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PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

RESEARCH WORK UNIT ANNUAL REPORTS

Year Ending March 31, 1970

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

Research Work Unit Annual Reports for Year Ending March 31, 1970

C O N T E N T S

FS-PNW	Work Unit Title and Leader
	TIMBER MANAGEMENT RESEARCH:
1201	Seeding, planting, and nursery practices in the PNW--Stein
1203	Silviculture of western forest types--Dahms
1204	Growth requirements, composition, culture, and productivity of mixed conifer forests, west side Cascades--Ruth
1206	Brushfield reclamation, prevention, and ecology--Gratkowski
1207	Silviculture of young-growth Douglas-fir and related species--Miller
1208	Prevention and control of animal damage to forest stands--Crouch
1301	Measurement and related timber management planning techniques in the Northwest--Bruce
1401	Breeding Pacific Northwest trees--Silen
	FOREST ENVIRONMENT RESEARCH:
1601	Water yield and erosion--Berndt
1602	Soil stability and streamflow--Rothacher
1603	Behavior and impact of forest chemicals--Tarrant
1701	Range environmental management--NW--Garrison
1801	Big-game habitat--Pacific Northwest--Smith
1901	Wilderness recreation dynamics--Hendee
1902	Cooperative recreation research--Wagar
	FOREST PROTECTION RESEARCH:
2103	Fuel appraisal--Fahnestock
2105	Forest fire science--Murphy
2201	Forest insect biology and ecology--Wickman
2203	Diseases of western forest insects--Thompson
2204	Forest insect nutrition and behavior--Carolin
2301	Diseases reducing forest production--Shea
2302	Root diseases and soil microbiology--Trappe
	FOREST SURVEY, ECONOMICS, PRODUCTS, MARKETING AND UTILIZATION, AND ENGINEERING RESEARCH:
3101	Grade and quality of western timber--Lane
3501	Effective use of wood in building construction (wood construction concepts)--Grantham
3701	Engineering systems for forestry operations in heavy timber and difficult access areas--Lysons
4101	Forest survey in the Pacific Northwest--Metcalf
4102	Improvement of forestry survey techniques--Pope
4201	Economics of timber growing--Schallau
4301	Improvement of markets, marketing systems, and methods of timber appraisal and sale--Hamilton

INSTITUTE OF NORTHERN FORESTRY

TIMBER MANAGEMENT RESEARCH:

1210 Silviculture of coastal forests in Alaska--Harris

1211 Ecology and growth requirements of subarctic trees and forests--Viereck

FOREST ENVIRONMENT RESEARCH:

1604 Erosion and sedimentation--Coastal forests--Helmers

FOREST PROTECTION RESEARCH:

2106 Fire control methods for Alaska--Barney

2206 Forest insects of coastal Alaska--Schmiege

2207 Forest insects--interior Alaska--Beckwith

FOREST ECONOMICS, PRODUCTS, MARKETING AND UTILIZATION, AND ENGINEERING RESEARCH:

4103 Forest survey for Alaska--Hutchison

UNITED STATES DEPARTMENT OF AGRICULTURE
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Annual Report for Pacific Northwest Forest and Range Experiment Station Research Work Unit FS-PNW-1201 for Year Ending March 31, 1970

1. Research Work Unit Location: Portland, Oregon.

2. Research Work Unit Title: Seeding, Planting, and Nursery Practices in the Pacific Northwest.

3. Mission: Develop more efficient reforestation practices for commercially important tree species in the Northwest.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	7	0	2	0	0	0	9	0
2	8	0	0	0	1	0	7	0
Total	15		2		1		16	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Survival and Early Growth of Planted Seedlings.

a. Published:

Owston, Peyton W. 1969. The shoot apex in eastern white pine: its structure, seasonal development, and variation within the crown. Can. J. Bot. 47: 1181-1188, illus.

Observations on the structure and seasonal development of the shoot apex of eastern white pine adds one more species to the limited number of pines on which these basic growth patterns

have been observed. The pattern for eastern white pine differs only in detail from that reported for other pines. Data from the study provided evidence for the view that the apical initial zone constitutes the true initiating region in the apical meristem. Terminal apices differed in size and development at different crown positions within individual trees. Existence of such variation indicates that the characteristics of a species should not be based on a limited sampling.

Stein, William I. 1969. 1968 listing of selected publications on reforestation. *In* Western reforestation. West. Reforest. Coordinating Comm. Proc. 1968: 57-65.

Speeding use of research information is one important means of getting intensified forestry. Reforestation information useful to the practicing forester in the West appears in many different publications. This selective compilation of current literature alerts him to the variety and scope of new information available.

b. Unpublished: None.

Problem No. 2--Success and Efficiency of Reforestation by Seeding.

a. Published:

Krueger, Kenneth W., and Ruth, Robert H. 1969. Comparative photosynthesis of red alder, Douglas-fir, Sitka spruce, and western hemlock seedlings. Can. J. Bot. 47: 519-527, illus.

Growth of red alder seedlings is truly impressive, whether the forest owner wants to grow alder as a commercial crop or discourage it in favor of conifers. Second-year seedlings of red alder, Douglas-fir, Sitka spruce, and western hemlock were found to have comparable photosynthetic rates at moderate light intensity and to distribute their growth similarly among leaves, stems, and roots. However, red alder used high light intensity better than the conifers. The leaves of red alder, moreover, provide a larger photosynthetic surface than conifer needles for the same weight of green tissue. These two advantages appear to favor the more rapid growth of alder seedlings under coastal forest conditions.

b. Unpublished: None.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Survival and Early Growth of Planted Seedlings.

a. New Studies:

Effect of container on survival, height growth, and root form of ponderosa pine.

Survival and growth of Douglas-fir and ponderosa pine planted by different methods.

Controlled atmosphere storage and subsequent survival and growth of Douglas-fir planting stock.

Transpiration rates of Douglas-fir and noble fir seedlings of different sizes.

Root form of ponderosa pine nursery stock as influenced by pruning.

b. Manuscripts:

Growth of frost-damaged Douglas-fir seedlings (Study No. A3--Station Research Note).

Growth of Douglas-fir seedlings subjected to various intensities of root pruning (Study No. A6--Station Research Note).

Effect of root-coatings on moisture and nutrient status of Douglas-fir and noble fir seedlings (Study No. A10--Tree Planters' Notes).

Moisture and toxicity tests on several candidate packing materials (Study No.--none. Tree Planters' Notes).

Survival of heeled-in ponderosa pine (Study No.--none. Tree Planters' Notes).

Top and root growth of Douglas-fir seedlings in response to root pruning (Study No. A6--Western Forest Nursery Council Proceedings).

Carbohydrate reserves, root regeneration potential, and field growth of Douglas-fir seedlings (Study No. A3--Station Research Paper).

Problem No. 2--Success and Efficiency of Reforestation by Seeding.

a. New Studies:

Growth response of Douglas-fir and noble fir seed on several media.

Improving germination tests for *Abies* species.

b. Manuscripts:

Growth of Douglas-fir, ponderosa pine, and western larch seedlings following seed treatment with undiluted hydrogen peroxide (Study No. H22--Station Research Note).

1969 listing of selected publications on reforestation Study No.--none. Western Reforestation).

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1203 for Year Ending
March 31, 1970

1. Research Work Unit Location: Bend, Oregon.

2. Research Work Unit Title: Culture of Coniferous Forests in the Interior Pacific Northwest.

3. Mission: To develop methods for producing wood on usable-sized trees more efficiently and in greater quantity.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	11		1				12	
2	2		1				3	
3	7						7	
4	4		1				5	
Total	24		3				27	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Improving Yields and Productivity of Ponderosa Pine Forests Through the Development of Improved Cultural Practices for Young Stands.

a. Published:

Barrett, James W. 1969. Crop-tree thinning of ponderosa pine. U.S.D.A. Forest Serv. Res. Note PNW-100, 13 pp., illus.

Three Pacific Northwest crop tree thinning studies showed that diameter growth of young ponderosa pine was substantially increased by cutting all trees within 5 to 8 feet of the crop tree. An additional increase in diameter growth was obtained by overstory removal. Thinning did not increase height growth of young crop trees, but overstory removal did.

b. Unpublished:

Four central Oregon field experiments showed that some fertilizers stimulated height growth of planted ponderosa pine, but the gain was small in comparison to the growth response foresters need to meet management objectives. The best fertilizer treatments produced a 10-inch height advantage in 6 to 7 years, and a 5-inch advantage in 3 years. The slowly available metal ammonium phosphate fertilizers show promise in pumice soils, but several more years are needed to fully assess their usefulness.

Problem No. 2--Developing Pioneer Information on Current and Potential Productivity of Major Species in the Interior Mixed-Conifer Types.

a. Published: None.

b. Unpublished: None

Problem No. 3--Boosting Yields in Lodgepole Pine Through the Development of More Definitive Information on the Initial Spacing and Level-of-Growing-Stock Requirements.

a. Published:

Youngberg, C. T. and Dahms, W. G. 1970. Productivity indices for lodgepole pine on pumice soils. J. Forestry 68(2):90-94.

In central Oregon, an area characterized by immature or weakly developed soils, productivity for lodgepole pine could not be delineated by soil series alone. Significant differences were recognizable within one soil series (Lapine) on the basis of the total thickness of the A and AC horizons. Stratifying stands on the basis of understory plant communities provided a better indication of productivity than did stratification on the basis of soil characteristics when basal area, site index, and volume increment were used as measures of productivity.

b. Unpublished:

The Twin Lakes lodgepole pine levels-of-growing-stock study demonstrated an effective transfer of growth from many small trees at high density levels to fewer, larger, more rapidly growing trees at the lower stand density levels. However, the high density treatments produced significantly more cubic feet of wood during the last 5 years. Periodic annual cubic volume increment during these years is expressed by the following equation: PAVI = 110.54x - 97.7 where: PAVI = periodic annual increment in cubic feet per acre, and x = logarithm to the base 10 of the beginning basal area. Evapotranspiration drain on soil moisture was also significantly greater at the higher stand densities.

Problem No. 4--Exploring Species-Site Relationships of Lodgepole Pine and Ponderosa Pine as a Basis for Determining Which Sites are Best Adapted to Establishment and Growth of Each Species.

a. Published:

Cochran, P. H. 1969. Lodgepole pine clearcut size affects minimum temperatures near the soil surface. U.S.D.A. Forest Serv. Res. Pap. PNW-86, 9 pp., illus.

Low night temperatures may hinder the establishment of lodgepole pine seedlings in certain areas within the Oregon pumice soil region. Lodgepole stands in these problem areas are several aged and occur on flat or depressional topography. Sky exposures (view factors) for circular and rectangular openings were calculated, and minimum temperatures at 2.5 inches above the soil surface were determined at various distances from the stand edge for a large rectangular opening. If low night temperatures do limit seedling establishment, strip clearcuts in the problem areas should not be wider than twice the height of the stand. If other factors dictate wider strips in these problem areas, plans should be made to plant the strip centers.

Cochran, P. H. 1969. Thermal properties and surface temperatures of seedbeds, a guide for foresters. U.S.D.A. Forest Serv. 19 pp., illus.

Heat flux density and thermal properties of soil control surface temperature variation. Slope, aspect, shade, water content, evaporation rates, wind, surface roughness, and color all influence either the soil heat flux density, the thermal properties, or both. All other factors being equal, soils with lower contact coefficients exhibit larger surface temperature variations.

Pumice soils have much lower thermal contact coefficients and thermal diffusivities than denser mineral soils. Large clearcut openings in flat or depressional areas in the pumice soil region accentuate the high probability of frost and often prohibit immediate establishment of ponderosa pine on those areas.

Modification of either the soil heat flux density or the soil thermal properties will change the environment of seedlings.

b. Unpublished: None.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Improving Yields and Productivity of Ponderosa Pine Forests Through Development of Improved Cultural Practices for Young Stands.

a. New Studies:

Install another replication of the west-wide levels-of-growing-stock study in a young stand where high density has not drastically reduced tree crown size.

b. Manuscripts:

Fertilizing planted ponderosa pine. (In Proceedings of Ponderosa Pine Regeneration Workshop. Publication expected in April or May 1970.)

Ponderosa pine sapling response to spacing and understory vegetation. (Station Paper.)

More forage plus a bonus--sawlogs. (J. of Soil and Water Conservation.)

Seeding ponderosa pine. (In Proceedings of Ponderosa Pine Regeneration Workshop.)

Problem No. 2--Developing Pioneer Information on Current and Potential Productivity of Major Species in the Interior Mixed-Conifer Types.

a. New Studies:

A combined initial spacing and continuous thinning study in grand fir.

A combined levels-of-growing stock and kind of thinning study in a 70-year-old larch stand.

Start a new study designed to estimate total stem wood producing capacity of larch on various soil-vegetation types.

b. Manuscripts:

Effect of fertilization on seedling growth of western larch. (Research Note.)

Problem No. 3--Boosting Yields in Lodgepole Pine Through Development of More Definitive Information on the Initial Spacing and Level-of-Growing-Stock Requirements.

a. New Studies: None

b. Manuscripts:

Thinned lodgepole pine shows good growth. (Research Note.)

Stand density control increases production of usable wood and water. (Research Paper.)

Problem No. 4--Exploring Species-Site relationships of Lodgepole Pine and Ponderosa Pine as a Basis for Determining Which Sites are Best Adapted to Establishment and Growth of Each Species.

a. New Studies:

Cubic volume increment of lodgepole pine as influenced by N, P, and S fertilization.

b. Manuscripts:

High soil water content tolerances of lodgepole and ponderosa pines. (Paper to be presented at the Annual Soil Science Society of America Meeting and to be published in the Proceedings.)

Responses of lodgepole and ponderosa pine seedlings to different temperature and nutrient regimes. (Ecology. Although most of the work will be done before March 31, 1971, appearance of the manuscript as a publication will probably be later.)

Variation in thermal diffusivities determined from diurnal soil temperature waves. (Note - Soil Science.)

Effect of Lapine Cl particle bridging and nutritional level on lodgepole and ponderosa pine seedling growth. (Research Note.)

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Annual Report for Pacific Northwest Forest and Range Experiment Station Research Work Unit FS-PNW-1204 for Year Ending March 31, 1970.

1. Research Work Unit Location: Corvallis, Oregon.

2. Research Work Unit Title: Culture of Mixed Conifers, West Side Cascades.

3. Mission: Develop improved cultural practices for multiple-use management and increased timber production in Pacific Northwest mixed conifer forests.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	8	0	0	0	0	1	7	0
2	5	0	0	0	0	0	5	0
3	12	0	0	0	3	0	9	0
Total	25				3	1	21	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Develop Productivity and Yield Information for Timber Management Planning.

a. Published: None

b. Unpublished:

Polymorphic site index curves for noble fir from stem analysis data were compiled from 54 locations in the Cascade Range. Site index was based on total height and age at breast height, with index age at 100 years. Equation form used to produce the curves

is $Age^2/Ht. = a + b(Age) + c(Age)^2$. Using such equations produced a range of heights for noble fir of 50 to 160 feet at index age. These preliminary curves will be used as a basis for the development of refined site index and productivity information for noble fir and associated species.

Securing site index information from stem analysis of old-growth trees has been handicapped by the frequent occurrence of lower stem rot. Where such rot contained discernible annual rings, ring counts otherwise difficult or impossible can readily be made by freezing the rotten sections. Frozen radial transverse rotten wood sections can be easily prepared for ring counts and sequential growth measurements using a sharp knife, razor, or rasp plane.

During recent stem analysis work involving 360 young, mature, and overmature mixed conifers in the Cascade Range true fir-hemlock forest type, a light weight, flex-handled, ratchet adapter was developed for long increment borers. The use of the adapter facilitated the collection of radial growth data from smaller diameter (0.165- to 0.177-inch) increment cores. The ratchet is readily adapted to increment borers of any length and should be especially useful where many cores are to be collected from wood difficult to bore.

Problem No. 2--Increase Productivity by Selecting the Species or Species Combination Best Adapted to Particular Sites.

a. Published:

Franklin, Jerry F., and Dyrness C. T. 1969. Vegetation of Oregon and Washington. U.S.D.A. Forest Serv. Pacific Northwest Forest & Range Exp. Sta. Res. Pap. PNW-80, 216 pp., illus.

Reports on the vegetation of the Pacific Northwest are fragmentary and scattered through a variety of sources, many unpublished. This has made it difficult for scientists, teachers, land managers, and students to be fully aware of what is known, how the various pieces fit together, and how the information can be applied to land management problems. This publication utilizes all available knowledge, synthesizing the material within a phytogeographic classification of the region, based on vegetation zones. Community composition, environmental relations, succession, and special community types are discussed and illustrated in each zonal description. An extensive bibliography leads readers to sources of more detailed information. This research paper has proved extremely valuable as an introduction to the plant ecology of Oregon and Washington. More important, it has provided a frame of reference for future research and pointed out significant aspects of the plant ecology of the region needing further research.

Franklin, Jerry F. 1969. Major vegetation types of Oregon and Washington. Absts. Papers Presented at XI Int. Bot. Cong. 1969: 63.

An abstracted version of the publication discussed above, describing the major vegetational zones in Oregon and Washington and the communities and environments which characterize them.

Minore, Don. 1970. Seedling growth of eight northwestern tree species over three water tables. U.S.D.A. Forest Service, Pacific Northwest Forest & Range Exp. Sta. Res. Note PNW-115, 8 pp., illus.

Productivity of lowland sites is highest where water table depths and species water table tolerances are optimally matched. However, this matching is not easily done in the field, for not all species can be found growing over the same water table depth on any single site, and water table depths differ from site to site. Three artificial water tables were therefore established to determine the relative water table tolerances of Douglas-fir, Sitka spruce, western hemlock, western redcedar, red alder, lodgepole pine, western white pine, and Pacific silver fir seedlings. Lodgepole pine, western redcedar, red alder, and Sitka spruce were all tolerant of shallow water tables; Douglas-fir was very intolerant. The deepest water table was optimum for all but Sitka spruce and red alder, which grew best over the intermediate depth. This information now makes it possible to compare water table depths and species productivity in the field--even where water tables and species composition vary from site to site.

Minore, Don. 1969. Yellow skunk-cabbage (*Lysichitum americanum* Hult. & St. John)--an indicator of water table depth. Ecology 50(4): 737-739.

Productivity of any lowland area is largely determined by the depth of its water table. Water tables fluctuate seasonally, however, and meaningful depth measurements are difficult and expensive to obtain directly, for they must be repeated at frequent intervals. This study was designed to provide a method of estimating water table depths indirectly. Skunk-cabbage density, skunk-cabbage petiole length, and the presence or absence of slough sedge (*Carex obnupta* Bail.) were successfully related to average winter water table depths in 11 lowland areas near the Oregon coast. Skunk-cabbage densities and petiole lengths varied inversely with water table depths when winter water tables were below the soil surface. Slough sedge was present whenever water tables were above the surface. By using these relationships, it is now possible to estimate average winter water table depths indirectly with one dry season vegetation measurement.

Minore, Don, Smith, Clark E., and Woollard, Robert F. 1969. Effects of high soil density on seedling root growth of seven northwestern tree species. U.S.D.A. Forest Serv., Pacific Northwest Forest & Range Exp. Sta. Res. Note PNW-112, 6 pp., illus.

Dense soils, whether natural or the result of compaction during logging operations, often limit forest regeneration and tree growth. This limitation can be minimized if areas with dense soil are managed for the species best able to grow in them. To determine which northwestern tree species are best suited to growth in dense soil, seedlings were grown in a greenhouse for two years over three artificially compacted soil densities. The roots of lodgepole pine, Douglas-fir, red alder, and Pacific silver fir penetrated soil densities that stopped the roots of Sitka spruce, western hemlock, and western redcedar. The former species are suitable for forest regeneration on old logging roads, landings, and hardpan areas; the latter species are not. Managing for Douglas-fir instead of Sitka spruce or western hemlock should shorten the regeneration period where high density soils are a problem in coastal Oregon and Washington.

Franklin, Jerry F., and Bishop, Norman A. 1969. Notes on the natural history of Mount Rainier National Park. Mount Rainier Natural History Assn. Publ., 24 pp., illus.

Considerable scientific knowledge about Mount Rainier National Park has accumulated in the last decade. However, most park guides are written for the lay public and of limited value to scientifically oriented visitors. Scientific knowledge about the natural history and points of interest in the Park are briefly summarized in this publication. The bibliography leads readers to the more detailed reports available. This publication has proved valuable as a scientific introduction and framework for scientists, students, and teachers visiting the Park.

Franklin, Jerry F. 1969. Review of "Fundamentals of Forest Biogeocoenology," edited by V. Sukachev and N. Dylis and translated from the Russian by J. M. MacLennan. Forest Sci. 15(3): 254.

Russian ecologists and pedologists have led in many aspects of ecological research. Frequently, their reports have not been readily available to English-speaking scientists. This review brings to the attention of forest scientists a major textbook outlining in detail current ecological theory and knowledge in Russia. It is the final product of the late V. Sukachev, the leading Russian ecologist in this century.

Franklin, Jerry F. 1969. Review of "Forest tree planting in arid zones," by A. Y. Goor and C. W. Barney. Plant Sci. Bull. 15(2): 6.

Tree planting in arid regions presents unique and difficult problems. This review brings to the attention of plant scientists a major textbook on afforestation practices in arid zones throughout the world.

Tarrant, Robert F., Lu, K. C., Bollen, W. B., and Franklin, J. F. 1969. Nitrogen enrichment of two forest ecosystems by red alder (*Alnus rubra*). U.S.D.A. Forest Serv., Pacific Northwest Forest & Range Exp. Sta. Res. Pap. PNW-76, 8 pp.

This report helps resolve the divergent viewpoints on the value of red alder in Pacific Northwest ecosystem management. Nitrogen content and total weight of litterfall were determined seasonally over 3 years in 40-year-old coastal Oregon forests of pure conifer (Douglas-fir, western hemlock, Sitka spruce), pure alder, and a mixture of the conifers and alder. Either in pure stand or as an admixture with conifers, red alder led to about a threefold increase in the amount of nitrogen circulating in litterfall. Red alder can be a potentially useful adjunct to managed forest stands and can be used to enhance forest soil fertility and forest productivity.

b. Unpublished: None

Problem No. 3--Increase Timber Production Through Development of Harvest Cutting Practices for Prompt and Adequate Restocking of Species Adapted to the Site.

a. Published:

Krueger, Kenneth W., and Ruth, Robert H. 1969. Comparative photosynthesis of red alder, Douglas-fir, Sitka spruce, and western hemlock seedlings. Can. J. Bot. 47(4): 519-527.

Photosynthetic rates expressed on a leaf-area basis did not differ greatly between species up to saturating light intensities for the conifers. The conifers, especially western hemlock, reached maximum rates at lower light intensities than did alder. Growing the four species under heavy shade tended to decrease species differences in photosynthetic rates. The distribution of plant weight between photosynthetic and nonphotosynthetic tissue was generally similar for all species, but alder produced more leaf area per unit weight of leaf. In the dark,

respiration rate per gram of top was highest for alder. Greater capacity to utilize high light intensities for photosynthesis, combined with more area per unit weight of leaf and greater total leaf area per seedling, may contribute substantially to alder's faster growth in high light situations. This basic information about Oregon coastal species will facilitate development of more efficient cultural practices for rapid regeneration of desired species.

Franklin, Jerry F., and Greathouse, Thomas E. 1969. Identifying noble fir source from the seed itself: A progress report. *In* Western Reforestation. Western Reforest. Coord. Comm., Western Forestry & Conserv. Ass. Meeting Proc. 1968: 13-16.

Verification of seed origin continues to be a serious concern, particularly where large lots of tree seed are in question. Data from 1967 and a few 1968 seed collections suggest the seed itself can be used to verify origin in the noble-Shasta red-California red fir species complex. Cotyledon number and seed weight vary systematically, increasing from north to south. Avoidance of off-site seed in reforestation work using these criteria will help eliminate substantial losses of productivity.

b. Unpublished: None

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Develop Productivity and Yield Information for Timber Management Planning.

a. New Studies:

Productivity of noble fir in relation to plant communities and environmental factors. (Develop productivity classes based on environmental indicators.)

b. Manuscripts:

Preliminary site index curves for noble fir. (Study No. 63--Station Note).

Accuracy of radial growth measurements from transverse wood sections. (Study No. 67--Station Paper).

Ratchet attachment for long-length, small-diameter increment borers. (Study No. 61--Journal of Forestry).

Technique for delineation of annual rings on rotten transverse wood sections. (Study No. 61--Station Note).

Techniques and problems of stem analysis of old-growth conifers in the Oregon-Washington Cascade Range. (Study No. 63--Tree Ring Conf. Proc.)

Problem No. 2--Increase Productivity by Selecting the Species or Species Combination Best Adapted to Particular Sites.

a. New Studies:

Soil texture-species relationships in coastal Oregon and Washington.

Long-term determination of species-site relationships in coastal Oregon and Washington with mixed-species plantations.

b. Manuscripts:

Effect of shade on germination and growth of salmonberry. (Station Paper).

A checklist of vascular plants on the H. J. Andrews Experimental Forest, western Oregon. (Research Note).

Sitka spruce--a bibliography with abstracts. (Station Paper).

Germination and early growth of coastal tree species on organic seedbeds. (Study W56--Station Paper).

Greenhouse growth of Douglas-fir and ponderosa pine on disturbed and undisturbed soils. (Soil Science).

Invasion of subalpine meadows by trees in Paradise Valley, Mount Rainier, Washington. (Ecology).

Problem No. 3--Increase Timber Production Through Development of Harvest Cutting Practices for Prompt and Adequate Restocking of Species Adapted to the Site.

a. New Studies:

None

b. Manuscripts:

Phenology of cone and shoot development of noble fir and some associated true firs. (Study W54--Forest Science).

Shade benefits Douglas-fir in southwestern Oregon cutover area. (Tree Planters' Notes).

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FOREST SERVICE

Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1206 (Rev.) for Year Ending
March 31, 1970.

1. Research Work Unit Location: Roseburg, Oregon

2. Research Work Unit Title: Brushfield Reclamation

3. Mission: To stop occupation of forest land by native shrubs and develop economical methods for controlling brush species in silviculture of Pacific Northwest conifers.

4. Summary of Research Work Unit Studies for each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	7	0	1	0	0	0	8	0
2	5	0	0	0	0	0	5	0
Misc.	0	0	0	0	0	0	0	0
Total	12		1				13	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Release of Conifers.

a. Published: None.

b. Unpublished:

Thimbleberry often occupies high site forest land in the Coast Ranges of Oregon and Washington after other brush species are killed with aerial sprays. Since thimbleberry is resistant to herbicides, this nullifies efforts to reforest many sites and hampers release of existing conifers on others. Low volatile esters of 2,4,5-T proved more effective than Amitrole-T in midsummer foliage sprays on thimbleberry in southwest Oregon. 2,4,5-T also proved as effective as combinations of picloram and phenoxy herbicides on thimbleberry and was more economical and less damaging to young Douglas-firs.

As a result of earlier tests, low volatile esters of 2,4,5-T are generally used to control chinkapins in the Pacific Northwest. New chemicals are screened, however, in efforts to find more selective, more economical, or otherwise more desirable chemicals for use on brush species. In recent tests, 2,4,5-T proved more effective than a potassium salt of picloram in foliage sprays on mature shrubs of golden evergreenchinkapin in the Siskiyou Mountains. Previously unreported tests had shown that 2,4,5-T esters are also more effective than salt and acid formulations of 2,3,6-trichlorobenzoic acid as foliage sprays on chinkapin.

Problem No. 2--Ecology of Brush Species

a. Published:

Gratkowski, H. 1969. Seral shrub communities of western Oregon. Abstracts XI Intern. Bot. Cong., Seattle, Washington. P. 76.

Western Oregon presents an unusually large variation in topographic, geologic, and climatic conditions, and this diversity of environmental conditions is reflected in the seral shrub communities. Deciduous species such as vine maple, salmonberry, and thimbleberry typical of shrub communities in northwestern Oregon extend southward along the coast and in cooler and wetter habitats along the crests of the Coast Range and Cascade Range. Evergreen shrubs including manzanitas, tanoak, live oak, and Ceanothus spp. are more abundant in the southern reaches of the Cascade Range and are predominant in the extensive broad-sclerophyll forest and chaparral of the southwestern valleys and Siskiyou Mountains. Several genera, especially Ceanothus, are adapted to regenerate after fire and are particularly abundant in secondary succession following logging or wildfires in the coniferous forests. Most brush-fields in western Oregon are seral shrub stages of forest climax associations.

b. Unpublished:

Blueblossom ceanothus shrubs compete with young coniferous trees for soil moisture and nutrients during the dry summer season in southwest Oregon. Laboratory experiments show that soil temperatures of 90° to 105° Centigrade will induce germination of dormant blueblossom seeds in forest soils. Soil temperatures in this range occur during wildfires and when logging slash is burned.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Release of Conifers.

a. New Studies:

Coast Range brush species. (Screening tests of herbicides on selected species.)

Douglas-firs in snowbrush. (Growth of young firs after various degrees of release from snowbrush.)

b. Manuscripts:

Seasonal variation in toxicity of herbicides to Pacific Northwest conifers and brush species (Study No. S33--Weeds).

Problem No. 2--Ecology of Brush Species

a. Studies:

Physiology of redstem ceanothus seeds. (Study ecology of redstem by response of pretreated seeds to controlled changes in relative humidity.)

Successional status of red alder. (Reconstruction of alder stand development on cuttings and burns.)

b. Manuscripts:

Heat as a factor in germination of varnishleaf ceanothus seeds--fire-induced germination (Study No. S30 and S32--Ecology.)

Anatomy and ecology of varnishleaf ceanothus seeds--how heat induces germination (Study No. S32--Journal of Botany.)

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Annual Report for Pacific Northwest Forest & Range Experiment Station
Research Work Unit FS-PNW-1207 for Year Ending
March 31, 1970

1. Research Work Unit Location: Olympia, Washington

2. Research Work Unit Title: Intensive Culture of Douglas-fir

3. Mission: To provide biological information necessary to improve efficiency with which timber crops of Douglas-fir and associated species can be grown to achieve a broad range of land management objectives.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	17	0	1	0	0	0	18	0
2	4	0	3	0	0	0	7	0
3	3	0	1	0	0	0	4	0
Total	24		5				29	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Growing Stock Control.

a. Published: None

b. Unpublished:

There are often sizable differences between actual volumes of trees and those estimated by standard volume tables. Furthermore, estimated volumes often indicate that two trees growing under nearly identical conditions are growing at quite different rates. This could result from a consistent over-estimate of growth of trees which are apparently growing better than expected, relative to other trees of similar size and competitive status, and to an under-estimate of growth of those apparently growing poorer than expected. To test this hypothesis, we determined actual volume on 32 trees which were selected to include a good representation of these deviations of estimated growth from expected growth. These trees sampled a wide range of size and growing conditions. Actual volumes at both age 41 (before treatment) and age 58 ranged from 79 to 112 percent of volumes estimated from a standard height-diameter volume table. Actual growth during this 17-year period ranged from 57 to 122 percent of that estimated by tabular volumes. However, contrary to what was anticipated, deviations from expected growth were not explained by the inaccurate volume estimates. Possible relationships with other variables are now being assessed.

In 1960, twelve shelterwood densities, ranging from 40 to 240 square feet of basal area, were established in a 60-year-old western hemlock stand. These densities were reduced by one-half in the second cut in 1964. In 1968, complete stem measurements of 45 trees, via optical dendrometer, showed that total cubic volume of individual dominant or codominant trees of any given initial diameter was constant for all densities. This indicates that treatment had no influence on cubic volume growth of these individual trees. The reason for this is that although release of residual trees in these shelterwood cuts stimulated diameter growth, it decreased height growth. Thus, stand volume growth estimates based solely on basal area growth can be more misleading than is commonly accepted, if height growth is depressed by heavy cutting intensities. In these stands, absolute form factor of individual trees, as of 1968, depend only on initial diameter in 1960, and not on residual stand density.

Problem No. 2--Soil Management and Improvement.

a. Published:

Strand, Robert F. and Richard E. Miller. 1969. Douglas-fir can be increased report from Pacific Northwest shows. Forest Industries. October 1969. 3 pp.

Results from forest fertilization research in the Pacific Northwest during the past two decades justify at least the following conclusions: (1) Nitrogen fertilizer can increase growth of Douglas-fir on a wide range of stand age, stocking levels, and site quality. (2) Other nutrient elements have not been adequately tested to evaluate their importance. (3) Optimum rates of N appear to lie between 150 and 300 pounds per acre for a response duration of 5-7 years following treatment. (4) In general, cubic-volume responses by Douglas-fir to nitrogen fertilizer range from 0 to over 100 percent and probably average about 30 percent during a 5- to 7-year period following treatment. (5) Existing fertilizer trials are potential sources of information about growth and yield in managed stands. They are local examples to help managers select stands for treatment. These conclusions certainly justify a much larger investment in research and development to be sure that we use fertilization's full potential for increasing wood supply at a reasonable cost.

b. Unpublished:

The Experiment Station has joined public and private organizations to support the "Regional Forest Nutrition Research Project" which is administered by the College of Natural Resources, University of Washington. The goal of this cost-sharing and coordinated project is to develop guides for planning large-scale fertilizer applications to forest lands. With contributions and assistance from cooperators, the University has begun to establish balanced series of 108 fertilizer trials in western Oregon and Washington in 15- to 60-year-old forests of Douglas-fir (720 plots) and hemlock (288 plots). These trials are designed to predict growth response to a given application of nitrogen under specific stand and environmental conditions. The cooperative funding will also support supplemental studies related to forest fertilization and tree response.

Widespread evidence of nitrogen deficiency in Douglas-fir has led to application of urea nitrogen to about 60,000 acres of forest land in western Washington and Oregon in 1969. This fertilizer, a dry, granular prill, was distributed by helicopter. Under certain conditions in agriculture, nutrient sprays have proved more effective than dry fertilizers per pound of nutrient applied. Most of the foliar spray is absorbed directly through the leaf surface and is immediately available for plant use. This greatly reduces the risk of the fertilizer becoming fixed by chemical and biological reactions in the soil.

We are comparing the effectiveness of various foliar sprays and dry urea prill when applied to seedlings and established stands of Douglas-fir. Fertilizers applied as spray caused the new needles of treated trees to be much darker green than those of untreated trees. For a given amount of nitrogen applied, spray caused a greater improvement in color than did granular urea. Only at the highest application rates tested was there appreciable loss of foliage. Because of the close correlation between needle color and growth of Douglas-fir, we anticipate that substantial increases in volume growth will result during the second and subsequent growing seasons. The long-term effectiveness of the spray versus prill treatment must be evaluated at a later date.

Problem No. 3--Shelterwood Harvest and Regeneration.

a. Published:

Ross, Stephen Douglas. 1969. Gross metabolic activity accompanying the after-ripening of dormant Douglas-fir seeds. Bot. Gaz. 130(4):271-275.

Changes in the lipid and sugar reserves and respiratory activity of dormant Douglas-fir (Pseudotsuga menziesii Mirb. Franco) seeds during stratification and germination were followed to provide some information on the after-ripening process. The dormant seeds were characterized by a low level of metabolism even when placed under conditions known to be favorable for germination. One day of stratification removed the block preventing lipid breakdown, but respiratory activity did not attain full capacity until the fifth day of stratification. Nearly 40 percent of the lipid reserves disappeared during stratification, over half of which could not be accounted for by respiration or as sugars. Further investigation is needed to determine the fate of the unaccounted-for carbon and to assess its role in preparing the seeds for germination.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Growing Stock Control.

a. New Studies:

Monitoring operational thinning and fertilizing in a 40-year-old Douglas-fir plantation at Snow Creek.

b. Manuscripts:

Crown development and site estimates in a Douglas-fir Plantation Spacing Test (Joint Study No. E8 with PNW Work Unit 1201--Forest Science).

Initial thinning effects in 70- to 150-year-old Douglas-fir. (Study No. C7--Journal of Forestry).

Forty-year development of Douglas-fir stands planted at various spacings (Study No. P6--Station Paper).

Effect of thinning on growth and yield at Voight Creek. (Study P8--Station Paper).

Response of individual trees to release. (Study P27--Forest Science).

Out-of-roundness in Douglas-fir tree stems (Study C2--Station Note).

Cooperative Levels-of-growing-stock study in Douglas-fir. (Station Misc. Pub.).

Problem No. 2--Soil Management and Improvement.

a. Studies:

Effectiveness of dry urea versus foliar sprays at Quilcene.

Effectiveness of helicopter-applied dry urea versus foliar sprays at Quilcene.

Optimal season and rates of dry urea and foliar sprays at Capitol Forest.

Response of dominant trees to thinning-fertilizing treatments at Tiller.

b. Manuscripts:

Effect of various fertilizers on tree growth and cone production in southwestern Oregon (Exploratory studies--Station Paper).

Problem No. 3--Shelterwood Harvest and Regeneration.

a. Studies: None

b. Manuscripts:

Shelterwood harvesting in western hemlock--interim results (Study No. P42--Station Paper).

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FOREST SERVICE

Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1208 for Year Ending
March 31, 1970

1. Research Work Unit Location: Olympia, Washington.

2. Research Work Unit Title: Prevention and Control of Animal Damage to Forest Stands.

3. Mission: To reduce economic losses to important tree species caused by animals in Western forests.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	3	0	0	0	0	0	3	0
2	8	0	1	0	0	0	9	0
3	6	0	0	0	0	0	6	0
Total	17		1				18	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Assessment of damage impacts.

a. Published:

Black, H. C., E. J. Dimock II, W. E. Dodge, and W. H. Lawrence. 1969. Survey of animal damage on forest plantations in Oregon and Washington. Trans., 34th North American Wildl. and Natural Resources Conf., March 2-5. Wildl. Manage. Inst. pp. 388-408.

Now nearing completion, a cooperative field survey of animal damage to forest plantations in Oregon and Washington shows that animals and birds are causing substantial losses in young Douglas-fir and ponderosa pine. Roughly, one of every three Douglas-firs and one of every six ponderosa pines planted is damaged annually during the first 4 years after planting. Browsing and clipping of stems were the chief causes of seedling injury, and deer were the most common damaging agent. Other animal agents in descending frequency of injury occurrence during 1968 were hares and rabbits, grouse, elk, mountain beaver, domestic stock, gophers, and porcupines. After four growing seasons, animals throughout the Region reduced height of all sample Douglas-fir seedlings by 10 inches. Over the same period, 35 percent of all Douglas-fir and 51 percent of all pine mortality was attributed to animal causes.

Crouch, G. L. 1969. Animal damage to conifers on national forests in the Pacific Northwest Region. PNW Forest & Range Exp. Sta., U.S.D.A. Forest Serv. Resource Bul. PNW-28. 13 pp.

A knowledge of the kind, location, and extent of animal damage to forest crops is essential for research planning. Replies to a questionnaire sent to all Ranger Districts in the Pacific Northwest Region indicated that animal damage to growing trees was more common on Oregon than Washington National Forests. Foliage browsing was the most common type of damage followed in order by barking, root gnawing, clipping, trampling, and loss of trees. Problem animals in order of importance were deer, porcupine, gophers, hare and rabbits, elk, livestock, small rodents, mountain beaver, and bear. Results from this survey together with on-the-ground inspections and appraisals by researchers have assisted in pinpointing major problems for organized research attack.

Dimock, E. J. II, and H. C. Black. 1969. Scope and economic aspects of animal damage in California, Oregon, and Washington. Proc., Wildl. & Reforest. in the Pacific Northwest Symp., Sept. 12-13, 1968. Ore. State Univ., Corvallis, Ore. pp. 10-14.

How do land managers assess damage caused by animals on public and private forests in California, Oregon, and Washington? Estimates of timber volumes and values lost plus the animals chiefly responsible vary considerably--reflecting a diversity of problems by landownership, as well as differing approaches to appraising damage.

Problem No. 2--Reduction of animal damage through use of chemicals.

a. Published:

Radwan, M. A. 1969. Effects of essential oils from three Douglas-fir clones on cellulose digestibility by deer rumen in vitro. (Abstr.). Annu. Mtg. West. Forest Genetics Assoc. 1969: 3.

Recent work with penned black-tailed deer has demonstrated that different genotypes of Douglas-fir are not equally preferred by the animals. In a study to evaluate factors influencing deer preference for the trees, essential oils from preferred and resistant Douglas-fir clones were evaluated for their effect on cellulose digestibility by deer rumen in vitro. Results suggest that essential oils of the plants may be associated with preference through their effect on rumen microbial digestion. This finding could make it possible to screen seedlings for resistance to browsing without use of live deer, and to use components of essential oils which inhibit digestion by deer as chemical protectants for preferred trees.

Radwan, M. A. 1969. Protection of coniferous seeds from rodents. Proc., Wildl. & Reforest. in the Pacific Northwest Symp., Sept. 12-13, 1968. Ore. State Univ., Corvallis, Ore. pp. 52-54.

Regeneration of conifers from seed is often delayed or entirely prevented by various rodents that destroy the disseminated seed before germination. Although the trend in artificial reforestation is presently toward planting rather than direct seeding, seeding will remain useful in many situations. In this paper, therefore, methods for protecting conifer seed from rodents are reviewed. These methods include use of mechanical devices, poison baits, toxicants and repellents, and biological control. The review suggests the need for strengthening research on protection of seeds, because measures now available for the control of rodents are inadequate.

Radwan, M. A. 1969. TMTD wild mammal repellent: Review and current status. Forest Sci. 15(4): 439-445.

A variety of measures to control browsing and clipping injuries have been suggested and used with some success against deer, rabbits, and hares. In recent years, considerable attention has been given to protecting seedlings from the offending animals through use of chemical repellents. Among chemicals tested, TMTD proved most useful. This paper reviews TMTD properties, assay methods, and use as a repellent against wild mammals. The review is the first complete summary of technical information on this widely used forest-animal repellent. It should be a valuable reference to both research workers and timber growers.

Radwan, M. A., and H. W. Anderson. 1970. Storing endrin-coated and endrin-impregnated Douglas-fir seed. PNW Forest & Range Exp. Sta., U.S.D.A. Forest Serv. Res. Pap. PNW-95. 6 pp.

In direct seeding, it is often necessary to store endrin-treated seed for periods ranging from a few days to several weeks. Effects of storage have been reported only for the southern pine species. Results of a study with Douglas-fir indicate that germination and seedling growth of endrin-coated and endrin-impregnated seed are not adversely affected by storage for up to 4 months regardless of storage temperature, provided that seed was dried after treatment and then stored in moisture-proof containers. Safe storage of endrin-treated seed will extend the season of direct seeding and make operations more efficient.

Radwan, M. A., G. L. Crouch, and W. D. Ellis. 1970. Impregnating and coating with endrin to protect Douglas-fir seed from rodents. PNW Forest & Range Exp. Sta., U.S.D.A. Forest Serv. Res. Pap. PNW-94. 17 pp.

Since the midfifties, endrin has been used for protecting conifer seed from rodents; yet only empirical guidelines for its use as a seed coating treatment are available and no successful attempts at impregnating seed with the chemical are known. In this study, therefore, effects of endrin, applied to Douglas-fir seed by the conventional coating method and by impregnation, were critically evaluated in the laboratory. Results show that the 0.5-percent endrin-coating treatment as now used on Douglas-fir in the Pacific Northwest does not give satisfactory protection from deer mice. On the other hand, impregnation of seed with endrin is possible without impairing seed viability. Impregnation provides for better protection than is now possible with the 0.5-percent coating treatment, with an essentially similar endrin concentration. In addition, endrin losses from seed during and after sowing and consequent contamination of the forest environment appear less likely from impregnated seed. However, because of expected higher cost and complexity of impregnating compared to coating, efforts should be made to increase effectiveness of coating. The techniques presented in this paper will undoubtedly prove helpful in developing a new seed protectant more acceptable than endrin.

Radwan, M. A., and W. E. Dodge. 1970. Fate of radioactive tetramine in small mammals and its possible use as a seedling protectant. Northwest Sci. 44(1): 25-30.

In spite of its extreme toxicity, tetramine has been considered a potential chemical for protecting tree seedlings from animals. Earlier, we investigated the fate of tetramine in plants and questioned its usefulness. The present study suggests that animals feeding on plants containing tetramine would tend to defecate most of the chemical in its original toxic form and lead to its distribution over the forest. Although the extent of the hazard involved is not known, all other known facts indicate that tetramine seems to have many serious disadvantages. Therefore, we cannot foresee any safe or effective use of the chemical to protect seedlings from animals.

Problem No. 3--Reduction of animal damage through modification of the forest environment.

a. Published:

Crouch, G. L. 1969. Deer and reforestation in the Pacific Northwest. Proc., Wildl. & Reforest. in the Pacific Northwest Symp., Sept. 12-13, 1968. Ore. State Univ., Corvallis, Ore. pp. 63-66.

Deer reside on nearly all forested and deforested land in the Pacific Northwest. In earlier times, deer and trees coexisted with little adverse affect on each other. With intensive management of timber, conflicts have gradually developed between the animals and the trees. This paper reviews the present knowledge of deer-reforestation interactions and problems. The occurrence and seasonal distribution of browsing on seedlings by deer are described and factors that influence browsing are considered. Browsing effects and methods, both currently available and potential, for controlling browsing are discussed.

Dimock, E. J. II. 1969. Feeding preference by snowshoe hare and black-tailed deer for differing Douglas-fir genotypes. (Abstr.). Annu. Mtg. West. Forest Genetics Assoc. 1969: 2.

Scattered past observations have led some foresters to believe that racial variation within a tree species may alter susceptibility to animal damage. Such variation could be effectively exploited to provide less damage-prone stock for planting or seeding. Widely varying attractiveness as forage of 13 Douglas-fir genotypes was shown in free-choice tests among captive black-tailed deer and snowshoe hare. Deer browsed certain genotypes twice as readily as others, and--for hare--differences in amounts consumed reach 3 to 1. Deer and hare preferences corresponded closely in most instances but were inconsistant in a few others. There has been virtually no correspondence between rate of Douglas-fir growth and susceptibility to animal feeding. Further tests with progeny of the same genotypes have shown that traits governing palatability are both dominant and transmittable to F-1 progeny through controlled breeding.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Assessment of damage impacts.

a. New Studies: None.

b. Manuscripts:

Seasonal variations in damage to Douglas-fir seedlings by snowshoe hare and black-tailed deer (Study No. None--Station Research Paper).

Ten-year height growth of Douglas-fir damaged by hare and deer. (Study No. None--Journal of Forestry).

Problem No. 2--Reduction of animal damage through use of chemicals.

a. New Studies:

Synthetic and naturally occurring chemicals to protect conifer seeds from rodents (To investigate new chemicals and chemical approaches to seed protection from rodents).

b. Manuscripts:

Chemical composition and digestibility of three Douglas-fir genotypes in relation to deer preference (Study No. None--Forest Science or Journal of Wildlife Management).

Arasan-endrin treatments to reduce rodent consumption of Douglas-fir seed (Study No. None--Journal of Forestry).

Factors affecting endrin content of endrin-coated Douglas-fir seed (Study No. None--Forest Science).

Effects of nursery fertilization of Douglas-fir seedlings with different forms of nitrogen (Study No. B9--Journal of Forestry).

Destruction of conifer seed and methods of protection (Study No. None--Proc., 4th Vertebrate Pest Control Conf., Calif.).

Urea nitrogen increases injury to Douglas-fir saplings by black-tailed deer, snowshoe hare, and sooty grouse (Study No. P53 (Nitrogen Supplement)--Science or Forest Science).

Problem No. 3--Reduction of animal damage through modification of the forest environment.

a. New Studies:

Partial cutting: Comparing animal use on tree seedlings and lesser vegetation under shelterwood and clearcutting harvest systems.

b. Manuscripts:

Douglas-fir seedling height influences browsing by black-tailed deer (Study No. None--Northwest Science).

Genotypic variation in Douglas-fir and feeding preferences by black-tailed deer and snowshoe hare (Study No. B5--Forest Science).

Planted versus natural Douglas-fir seedlings and their relative susceptibility to deer, hare, and mountain beaver (Study No. P53--Tree Planters' Notes).

Seasonal feeding preferences of pocket gophers for Jeffrey, lodgepole, and ponderosa pines (Study No. B3--Journal of Forestry).

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1301 for Year Ending
March 31, 1970

1. Research Work Unit Location: Portland, Oregon.

2. Research Work Unit Title: Timber Measurement PNW.

3. Mission: To develop more efficient timber measurement and forest management planning techniques.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated[1/]	Active	Inactive
1	4	0	0	0	1	0	3	0
2	6	0	0	0	0	0	6	0
3	1	0	0	0	1	0	0	0
Total	11				2		9	

1/ Studies that have been stopped before completion with no intention of reactivation.

5. Accomplishments for Each Selected Problem:

Problem No. 1--Timber Measurement Techniques.

a. Published:

Bruce, David. February 1970. Estimating volume of Douglas-fir butt logs. USDA Forest Serv. Res. Note PNW-117, 5 pp., illus.

A physical model was used in derivation of an equation that estimates the cubic-foot volume of flaring Douglas-fir butt logs. This equation has a standard error of 3 percent. It requires the accurate measurement of length and of top and butt diameters. Other equations sometimes used for same purpose have 10 to 15 percent high bias.

b. Unpublished:

Preliminary work with Douglas-fir indicates that--for mature trees--the stem profile can be described by the square root of a polynomial involving several low powers (3/2, 2, 3) and one high power (30) of relative height and interactions with height and height/d.b.h. These are quite similar to those previously used for red alder. Data are being sought from a wider range of tree sizes and stand conditions so that generally applicable equations can be derived.

Problem No. 2--Growth and Yield Studies.

a. Published:

Post, Boyd W., Carmean, Willard H., and Curtis, Robert O. 1969. Birch soil-site requirements. USDA Forest Serv. Northeastern Forest Exp. Sta. Birch Symp. Proc. 1969: 95-101, illus.

Summarizes current knowledge of soil-site relationships for yellow birch and white birch.

b. Unpublished: None.

Problem No. 3--Timber Management Planning.

a. Published:

Bruce, David. 1969. Potential production in thinned Douglas-fir plantations. USDA Forest Serv. Res. Pap. PNW-87, 22 pp., illus.

Nine foreign production tables for Douglas-fir (thinning guides) were converted to American units of measure and to Pacific Northwest site indexes. They suggest that potential yields of thinned stands in the Pacific Northwest are higher than has been estimated on the basis of natural unthinned stands, and that culmination of merchantable mean annual production with heavy thinning may occur at 65 to 80 years. These results provide guides to potential production with management practices equal to those in foreign plantations, until experience with managed stands in the Pacific Northwest can improve them.

b. Unpublished: None.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Timber Measurement Techniques.

a. New Studies:

Triple-entry volume and taper equations for conifers.

Dendrometer accuracy testing.

Use of cubic volume and product estimates in timber sales.

Techniques of estimating attributes of sample scaling.

b. Manuscripts:

An adjustable unipod for tree-measuring instruments (Study No.--none. Journal of Forestry).

Predicting product recovery from logs or trees (Study No. E5--Station Paper or Station Note).

Problem No. 2--Growth and Yield Studies.

a. New Studies:

Methods for preparation of site index curves from stem analyses.

Individual tree increment of Douglas-fir in relation to age, site, density, and competitive position.

b. Manuscripts:

Crown development and site estimates in a Douglas-fir plantation spacing test (Study E8--Forest Science).

Stand density measures: an interpretation (Study E10--Forest Science).

Stand density measures and $\Sigma(D_i^b)$ in Douglas-fir (Study E10--Forest Science).

Yield tables past and present (Study No.--none. Journal of Forestry).

Estimation of northern hardwood site index from soils and topography in the Green Mountains of Vermont (Study No.--none. Vermont Agricultural Experiment Station Paper).

Preliminary site index curves for noble fir from stem analysis data (Study No.--none. Station Note).

Problem No. 3--Timber Management Planning Procedures

a. New Studies: None.

b. Manuscripts: None.

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FOREST SERVICE

Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1401 for Year Ending
March 31, 1970

1. Research Work Unit Location: Corvallis, Oregon.

2. Research Work Unit Title: Breeding Pacific Northwest Trees.

3. Mission: To safely, yet substantially, improve yields of Pacific Northwest forests through genetics research.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	10	0	1	0	0	0	11	0
2	16	0	0	0	0	0	16	0
5	3	0	0	0	0	0	3	0
Total	29		1				30	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Seed Orchard and Tree Breeding Technique.

a. Published:

Copes, Donald L. Remedy for graft incompatibility in Douglas-fir seed orchards. In Western Reforestation. West. Forest. and Conserv. Ass. West. Reforest. Coordinating Comm. Proc. 1968. pp. 19-22 (1969).

Two methods are proposed for overcoming graft incompatibility losses in new orchards. One method tests all stock-scion combinations, replacing incompatible ones with other parentage. The other method tests a 10-12 graft sample of each new parent and calls for rooting more understock when a compatible combination is found.

Copes, Donald L. Graft union formation in Douglas-fir. Amer. J. Bot. 56(3): 285-289 (1969).

In most respects, grafts of Douglas-fir followed development patterns previously reported for spruce and pine grafts, but specific differences were noted in contributing cell types, time of formation, and mode of healing.

Copes, Donald L. Effect of graft type on 6-month survival of field grown Douglas-fir grafts. Pac. NW. Forest and Range Exp. Sta. Res. Note 104, 5 pp. (1969).

A study on field survival after 6 months of top-cleft, splice, and side grafts revealed that graft type and technique were not significant sources of variation when 80 mm. or more of cambial contact connected the stock and scion.

Copes, Donald L. The relationship between Douglas-fir graft compatibility and wood specific gravity. Proc. Western Forest Genet. Ass., Placerville, Calif. (Abstr.) p. 1 (1969).

Linear correlation between graft compatibility and wood specific gravity were computed for 50 Douglas-fir clones. No significant correlations at 0.05 level were found between graft incompatibility and juvenile wood, adult wood, or approximate tree average. Lack of correlation discourages use of specific gravity as an aid in selecting graft compatible plus-trees.

b. Unpublished: No activity.

Problem No. 2--Inheritance of Growth and Related Traits.

a. Published:

Silen, Roy R. Increasing yields through tree improvement. In Proc. of The 60th Western Forest. Conf., Western Forest. and Conserv. Ass. pp. 49-52 (1970).

Forestry restraints, in the form of reforestation rates, program implementation and past negative selection, limit tree improvement returns to modest Westwide gains in the short run. Long run prospects, or gains for the local landowner, are optimistic.

Silen, Roy R. and Boyd C. Wilson. Douglas-fir 100 tree progeny test objectives and establishment. Christmas Tree Growers' Short Course, March 1970, Union, Wash. Distr. by Wash. State Dept. of Natural Resources, Forest Land Manage. Div., Contrib. No. 124 (1970).

Aimed at identifying 10 best study parents in each state from which commercial quantities of seed can be collected. Some families are already exhibiting considerable superiority.

Sorensen, Frank C. Embryonic genetic load in coastal Douglas-fir, Pseudotsuga menziesii var. menziesii. Amer. Natur. 103(932), pp. 389-398 (1969).

Inbreeding embryonic loads of 2.3 to 27.6 lethal equivalents (median 9 or 10) were estimated for 35 coastal Douglas-fir trees using comparison of seed set following self- and cross-pollination.

b. Unpublished: No activity.

Problem No. 5--Improvement of species other than Douglas-fir.

a. Published: No activity.

b. Unpublished: No activity.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Seed Orchard and Tree Breeding Technique.

a. New Studies:

Use of paired genes for albinism to estimate relative proportions of self, near neighbor, and long distance pollen received by seed orchard Douglas-fir trees.

b. Manuscripts:

Estimate of genetic variance in juvenile height-growth of Douglas-fir (Study No. 33--Silvae Genetica).

Progeny growth as related to chemical fertilization of seed-trees in Douglas-fir (Study No. 34--Forest Science).

Effect of scion and rootstock conditions on survival and first-year growth of Douglas-fir grafts (Study No. 24--Journal of Forestry).

Initiation and development of graft incompatibility symptoms in Douglas-fir (Study No. 24--Silvae Genetica).

Effect of date of grafting on graft survival in Douglas-fir (Study No. 24--PNW Station Research Note).

Double-grafts in Douglas-fir (Study No. 24--Forest Science).

External detection of incompatible Douglas-fir grafts (Study No. 24--International Plant Propagators Society).

The relationship between Douglas-fir graft compatibility and wood specific gravity (Study No. 24--Journal of Forestry).

A second trial of cold water spray to avoid pollen contamination of Douglas-fir seed orchards (Study No. 16--PNW Station Research Note).

Problem No. 2--Inheritance of Growth and Related Traits.

a. New Studies: None.

b. Manuscripts:

Inheritance of taper in ponderosa pine families (Study No. 38--PNW Station Research Note).

Caged hare tests of Douglas-fir (Study No. B5--PNW Station Research Note).

Estimate of self-fertility in coastal Douglas-fir from inbreeding studies (Study No. 20--Silvae Genetica).

Problem No. 5--Improvement of Species Other Than Douglas-fir.

a. New Studies: None.

b. Manuscripts:

The seed source question for ponderosa pine (Study No. 3--Symposium on Ponderosa Pine Regeneration Short Course, Ore. State Univ., Sept. 1969).

Self-fertility of a central Oregon source of ponderosa pine (Study No. 20--PNW Station Research Paper).

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1601 (Rev.) for Year Ending
March 31, 1970

1. Research Work Unit Location: Wenatchee, Washington

2. Research Work Unit Title: Water Yield and Erosion

3. Mission: To devise ways to improve water yield, prevent erosion, and restore land stability; and to determine how moisture disposition and erosion are influenced by climate, topography, land use, types of vegetative cover, and soil.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Re-activated	Com-pleted	Termi-nated[1/]	Active	Inactive
1	7	0	2	0	4	0	5	0
2	5	0	3	0	3	0	5	0
Total	12		5		7		10	

[1/] Studies that have been stopped before completion with no intention of reactivation.

5. Accomplishments for Each Selected Problem:

Problem No. 1--Water Yield Improvement.

a. Published:

Berndt, H. W., and Swank, G. W. 1970. Forest land use and streamflow in central Oregon. U.S.D.A. Forest Serv. Res. Pap. PNW-93, 15 pp., illus. Abstr. In: Northwest Sci. 44(1): 59. 1970.

A case study was made of land use activities and hydrologic performance of a 295-square-mile forested basin in central Oregon for the period 1922-65. A significant increase in streamflow beginning about 1942 was noted. In considering levels of past and present land use activities, this change in water yield efficiency seems to be most closely tied to increased timber harvest activity within the basin.

Though the formal studies underway to provide sensitive, refined tests of the influence of vegetation on water yield east of the Cascade Range are yet needed, these analyses of existing data and records provide some insight to the effects of forest management activities. They also support the belief that the interacting character of forest resource management can benefit watershed objectives.

Fowler, William B. 1969. A digital indicator for maximum windspeeds. U.S.D.A. Forest Serv. Res. Note PNW-98, 4 pp., illus.

During recent study of meteorological sequences associated with rime accumulation in high elevation timber stands, methods of digitizing various atmospheric measurements for portrayal to time-lapse camera record were designed.

A simple device for indicating maximum windspeed during a specified time interval was developed. Voltage output from a generator-type anemometer was sensed by way of a unijunction transistor, compared with a reference voltage, and the unbalance displayed by coded light for photo-sensing along with other synchronous data. The device resets automatically at the end of each sample period.

The system is battery operated, with low current drain for long periods of unattended service.

Herring, H. G. 1970. Soil moisture trends under three different cover conditions. U.S.D.A. Forest Serv. Res. Note PNW-114, 8 pp., illus.

Knowledge of soil moisture variations resulting from differing cover conditions is necessary where land management objectives include watershed management. A 3-year study was made of summer soil moisture trends in a grassy opening, a second-growth ponderosa pine stand, and a clearcut ponderosa pine plot in central Washington.

On deeper soils it was found that the grassy openings and the second-growth stand had very similar moisture regimes except during years preceded by abnormally low winter precipitation. Removing ponderosa pine resulted in a significant initial alteration of moisture regime and higher moisture content at the end of the growing season.

In terms of autumnal moisture savings, assuming pine-to-clearcut as the maximum attainable savings, grass cover is only 20 percent as effective as the cleared plot. The absolute value of moisture savings is highly dependent upon the weather.

Klock, G. O., and Lopushinsky, W. 1970. Use of thermocouple psychrometers to measure soil water potential in the root zone of conifer seedlings. (Abstr.) Northwest Sci. 44(1): 64.

Increasing use is being made of psychrometric methods for assessing energy status of water in biological systems. The development of miniature Peltier thermocouple psychrometers has spurred even more interest.

Psychrometers were constructed and placed in the root zone of more than 150 individually potted, transpiring conifer seedlings. Soil water potential was directly monitored over the range of one to 50 bars.

This technique proved to be a quick and accurate method for measuring soil water potential. More importantly it is a direct measure of total soil water stress in the root zone which can be related to transpiration rates of conifer seedlings.

Lopushinsky, William. 1969. A portable apparatus for estimating stomatal aperture in conifers. U.S.D.A. Forest Serv., Pacific Northwest Forest and Range Expt. Sta., 7 pp., illus.

A compact portable apparatus for estimating stomatal aperture in conifer needles by the pressure-infiltration method was designed and constructed. Results of a test with Douglas-fir and several ethanol-water mixtures showed that a 50- to 60-percent ethanol-in-water solution was the best infiltration fluid.

A transpiration test with ponderosa pine and a 57-percent alcohol solution showed that the stomata can be considered fully open at an infiltration pressure of 10 p.s.i. or less, and essentially closed at 40 p.s.i.

Designed for field application, this equipment will feature prominently in transpiration studies aimed at determining water use requirements, and biological controls over water loss, in conifer forest stands.

Lopushinsky, William. 1969. Stomatal closure in conifer seedlings in response to leaf moisture stress. Bot. Gaz. 130(4): 258-263, illus.

The water content of foliage and moisture stress of twigs associated with stomatal closure were determined for 3-year-old seedlings of ponderosa pine, lodgepole pine, grand fir, Douglas-fir, and Engelmann spruce. Stomatal behavior during increasing soil drought was interpreted from transpiration trends of potted seedlings kept under controlled conditions, and relative degree of stomatal opening was determined with a pressure infiltration technique.

In grand fir and Douglas-fir, a decline in transpiration rate in response to drought was associated with a relatively small reduction in size of stomatal aperture as compared with the pines and spruce, indicating that mesophyll resistance may have been a significant factor limiting transpiration in the firs. At stomatal closure, or end of the transpiration decline, needle water contents ranged from 122.5% to 162.5% and were lowest in Engelmann spruce and Douglas-fir, intermediate in the pines, and highest in grand fir.

The data on plant moisture stress indicates that the stomata of the pines and spruce are relatively sensitive to leaf moisture stress while those of Douglas-fir and particularly grand fir are less sensitive. Transpiration-decline curves obtained with excised twigs indicated that stomatal closure also occurred more rapidly in the pines and spruce than in the firs. From a management standpoint, species which close their stomata quickly in response to a low water stress would be more economical users of water than species in which the stomata did not close until a high stress had been attained.

b. Unpublished: None.

Problem No. 2--Erosion Reduction

a. Published:

Anderson, T. D. 1970. Seasonal variation in physical and chemical properties of two central Washington soils. (Abstr.) Northwest Sci. 44(1): 58.

Soils derived from two widely distributed parent materials in central Washington were examined periodically during 1968-69 for physical and chemical properties. Basalt soils showed significant seasonal variation in Na content, cation exchange capacity, and pH. In sandstone soils, Ca, Mn, Na, N, K, and organic content varied significantly among sampling dates. Although certain physical properties showed definite trends, none were statistically significant.

These results indicate that, where sampling dates vary, seasonal variation in certain chemical properties of these soils may be a confounding factor in evaluating research findings or management prescriptions.

Fowler, William B. 1970. A spring-actuated maximum temperature indicator. J. Range Manage. 23(2): 144-145, illus.

Inexpensive, positive temperature indicators were made from temperature-sensitive waxes and simple spring-wire carriers. A uniformly reflective coat of aluminum powder was applied to indicators of all temperature ranges.

Studies of plant cover rehabilitation problems require determination of seasonal variation of maximum air temperatures near the soil surface. More accurate sampling of this important environmental factor is now possible with responsive, easily read, maximum temperature indicators, operating between 38 and 62 C.

Fowler, W. B., and Berndt, H. W. 1969. Fluorescent materials index soil movements. U.S.D.A. Forest Serv. Res. Note PNW-107, 7 pp., illus.

Tracing movement and dispersion of soil-sized fluorescent particles is considered a promising method for detecting and describing soil erosion. Actively eroding and stable sites were readily identified; size of particles in motion and causal agents were also inferred.

There is need for easy-to-use methods of recognizing or identifying active erosion, determining its cause, and appraising relative rates. Fluoremetric particle identification in general involves the introduction of traceable artificial particles into a natural environment. The introduced material, Willemite, was chosen to closely resemble and reproduce the transport characteristics of natural particles.

Equipment is simple to operate, and no health hazards are involved.

Klock, G. O. 1969. Some autecological characteristics of elk sedge. U.S.D.A. Forest Serv. Res. Note PNW-106, 5 pp., illus.

'Scores' or plugs of elk sedge were successfully transplanted to the laboratory to investigate this method of reproduction and to provide material for tests of this plant's response to fertilization. Elk sedge showed positive response to nitrogen and potassium fertilization.

Many conservationists feel that select native grass and grass-like plants provide the most desirable soil stabilization cover on wildlands. One such plant is elk sedge (Carex geyeri Boott). Elk sedge, with an extensive fibrous root system and apparently high drought resistance, may be one of the most important native forage species and soil binders on forest and related lands of eastern Oregon and Washington. Information on establishment of this species by this means is an important consideration to rehabilitation of disturbed sites.

Klock, G. O. 1969. Forest and range soils research in Oregon and Washington; a bibliography with abstracts from 1964 through 1968. U.S.D.A. Forest Serv. Res. Paper PNW-90, 28 pp.

An annotated bibliography continuing a series previously published in 1956, 1957, 1958, 1959, and 1964.

b. Unpublished: None.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Water Yield Improvement

a. New Studies:

Seasonal variation in transpiration rate of Douglas-fir and ponderosa pine in relation to soil moisture stress

Radiation climatology of the Entiat Experimental Watersheds

The relationship between surface temperature and visual characteristics of east Cascade forest and range types

b. Manuscripts:

An improved micro-welding technique for thermocouple psychrometers (Soil Science Society of America Proceedings)

Relation of transpiration rates to soil moisture stress (Forest Science)

A preliminary report on the effect of thinning on snow accumulation and soil moisture levels in ponderosa pine (Station Release - Research Note)

Photorecording for target information and readout storage of remotely sensed temperature (Northwest Electronics Instrumentation Conference)

Adaptation of the proving ring to continuous measurement of tree weights (Station Release - Research Note)

The effect of first-year fertilization on daily height growth of juvenile Douglas-fir (Journal of Forestry)

Seasonal correlograms of Godske's measurements of bihourly height growth reveal basic yearly differences (Station Release - Research Note)

Problem No. 2--Erosion Reduction

a. New Studies:

Response of elk sedge and pinegrass to shade and defoliation

Nitrogen and sulfur utilization and deficiency on three important soil types of eastern Oregon and Washington

b. Manuscripts:

Microsite differences in air temperature near the surface at several elevations (Journal of Range Management)

Meeks Table - A Research Natural Area (Station Release - Research Paper)

Seasonal variation in soil physical and chemical properties (Station Release - Research Note)

Effect of mesquite on vegetation and soils in the desert grassland (Ecology)

Response of four perennial southwestern grasses to shade (Journal of Range Management)

Comparison of nutrient availability in soil under mesquite trees and in open (Soil Science Society of America Proceedings)

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1602 for Year Ending March 31, 1970

1. Research Work Unit Location: Corvallis, Oregon.

2. Research Work Unit Title: Soil Stabilization and Runoff Regulation in Conifer Watersheds in Washington and Oregon (Soil Stability and Streamflow).

3. Mission: To determine how logging methods, road construction, and other forest management practices can be improved to curtail erosion, maintain water quality, provide favorable stream environment, and regulate quantity and timing of runoff from conifer watersheds in western Oregon and Washington.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	6	1				1	6	
2	4	0					4	
3	5	0					5	
4	0	0					0	
Total	15	1				1	15	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Maintain Soil Stability.

a. Published:

Dyrness, C. T. 1969. Hydrologic properties of soils on three small watersheds in the Western Cascades of Oregon. Pacific Northwest Forest & Range Exp. Sta. U.S.D.A. Forest Serv. Res. Note PNW-111, 17 pp., illus.

Detailed soil mapping on three small experimental watersheds resulted in the delineation of eight soil series and 46 mapping units. All soils were of loamy texture and most showed minimal amounts of profile development. With one exception, rates of water movement through saturated soil cores were found to be very high. Percolation rates measured for surface horizons were unusually rapid due to the very porous and highly aggregated nature of these layers. Retention and detention water storage capacity values determined for the surface 4 feet of soil were extremely variable within individual soil series. The single most important factor causing variation in storage capacity values was stone content of the soils. Each of the four most widespread soil series was divided into two new soil units on the basis of stone content. The result was soil units with substantially reduced variation in water storage capacity values. Average retention storage capacity values for the surface 4 feet of soil ranged from approximately 6 to 14 inches and average detention capacities varied from about 8 to 14 inches. Maximum storage capacity available at the end of the summer dry season is estimated to range from about 30 to 40 percent of the total retention capacity values for these soils.

Franklin, Jerry F. and Dyrness, C. T. 1969. Vegetation of Oregon and Washington. Pacific Northwest Forest & Range Exp. Sta. U.S.D.A. Forest Serv. Res. Pap. PNW-80, 216 pp., illus.

Describes and illustrates major vegetational types found in Oregon and Washington including forest types, steppe and shrub-steppe communities, and subalpine mosaics. Successional and environmental relationships of the communities are discussed. An extensive bibliography directs the reader to more detailed sources.

Dyrness, C. T. 1969. Early plant succession following logging and slash burning in *Pseudotsuga* forests in Oregon. (Abstr.) Abstracts of papers presented at the XI International Botanical Congress, Aug. 24-Sept. 2. p. 50.

For 7 years, vegetative cover and composition were observed on permanent plots in three logged clearcuts in Oregon's

western Cascades: the year prior to cutting the old-growth *Pseudotsuga menziesii - Tsuga heterophylla* stand and during each of five growing seasons following logging and broadcast burning of slash. Total plant cover was 15 percent the first year after slash burning, greatly increased to 49 percent the second, and showed consistent, more modest increases the ensuing 3 years. By the fifth growing season after slash burning, plant cover totaled almost 80 percent--6 percent contributed by tree species, 17 percent by tall shrub species, and 57 percent by low shrub and herbaceous species. Vascular plant species totaled 48 before logging and increased to 72 species 6 years after logging. The most important invaders were *Ceanothus velutinus, Anaphalis margaritaceae, Epilobium angustifolium, E. paniculatum,* and *Senecio sylvaticus.* Residual species which increased substantially in cover and frequency after logging included *Rubus ursinus, Hieracium albiflorum, Linnaea borealis, Oxalis oregana, Trientalis latifolia, Galium triflorum,* and *Whipplea modesta.* Relationships of species composition to degree of soil disturbance and prelogging plant community will also be discussed.

b. Unpublished: None.

Problem No. 2--Preventing Water Quality Deterioration.

a. Published:

Fredriksen, R. L. 1969. A battery powered proportional stream water sampler. Water Resources Res. 5(6):1410-1413.

A stream water sampler was designed and tested to sample water from a stream at a rate proportional to the streamflow rate. A composite of samples taken in this manner is an estimate of the mean concentration of constituents carried by the stream while the sample was collected. The instrument is suitable for estimates of transport of suspended or dissolved constituents in small streams. The sampler can be built for under $1000.

Fredriksen, Richard L. 1970. Erosion and sedimentation following road construction and timber harvest on three small watersheds in western Oregon. (Abstr.) Northwest Sci. 44(1):62.

This paper reports sedimentation of small streams resulting from 1) high-lead logging to forest roads; 2) skyline logging without roads; 3) an undisturbed watershed. These watersheds exhibit mature topography, old-growth Douglas-fir cover, and fine textured soils. Sedimentation increased to 109 times from 1), and 3.3 times from 2) compared to 3). The major mechanism of erosion was landslides. Erosion resulted from conditions that concentrated large amounts of water in detention storage. Source of this water was from rainfall and snowmelt. Most landslides occurred at toe slope and headwall locations. Forest roads were a major source of erosion where they crossed live streams.

Problem No. 3--Predicting Changes in Stream Hydrology.

a. Published: None.

b. Unpublished: None.

Problem No. 4--Maintain Favorable Stream Environment.

a. Published:

Levno, Al and Rothacher, Jack. 1969. Increases in maximum stream temperatures after slash burning in a small experimental watershed. Pacific Northwest Forest & Range Exp. Sta. U.S.D.A. Forest Serv. Res. Note PNW-110, 7 pp., illus.

The first year after slash was burned on a 237-acre clearcut watershed in the Cascade Range of Oregon, average maximum water temperatures increased 13°, 14°, and 12° F. during June, July, and August. A maximum stream temperature of 75° F. persisted for 3 hours on a day in July.

b. Unpublished: None.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Maintain Soil Stability.

a. New Studies: None.

b. Manuscripts:

Early stages of plant succession following logging and slash burning in the Western Cascades of Oregon (Study No. C-12, Ecology, Dyrness).

Soil stabilization by mulch and grass-legume treatment on a newly constructed road backslope (Study No. C-19, Research Note, Dyrness).

Effect of balloon logging on surface soil properties (Study No. C-13, Research Note, Dyrness).

A checklist of vascular plants in the H. J. Andrews Experimental Forest (Study No. C-21, Research Note, Franklin and Dyrness).

Surface soil movement on steep land following slash burning (Study No. C-19, Research Note, Mersereau and Dyrness).

Genetic and stability relationships of four Western Cascade soils (Cooperative Agreement Supplement No. 50, O.S.U., Paeth).

Problem No. 2--Preventing Water Quality Deterioration.

a. New Studies: None.

b. Manuscripts:

Erosion and sedimentation following road construction and timber harvest on unstable soils in three small western Oregon watersheds (Study No. C-4, Research Note, Fredriksen).

Managing forest land for water quality (Forest Influences and Watershed Management Symposium, U.S.S.R. Rothacher).

Comparative water quality--natural and disturbed streams (Forest Land Use and Fish Habitat Symposium, O.S.U., Fredriksen).

Problem No. 3--Predicting Changes in Stream Hydrology.

a. New Studies: None.

b. Manuscripts:

Water yield increases following clearcut logging in the Pacific Northwest (Study No. 2, Water Resources Research, Rothacher).

Effect of logging on peak streamflow (Study No. 2, Research Note, Rothacher).

Soil water changes in a Douglas-fir forest following clearcutting of old-growth Douglas-fir (Study No. C-20, Research Note, Fredriksen).

Regimes of streamflow and their modification by logging (Forest Land Use and Fish Habitat Symposium, O.S.U., Rothacher).

Problem No. 4--Maintain Favorable Stream Environment.

a. New Studies:

Streamside management for temperature control.

b. Manuscripts:

Changes in temperature of water flowing from a 15,000-acre drainage being logged by the patch-cut system (Study No. 1, Research Note, Mersereau).

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1603 for Year Ending March 31, 1970

1. Research Work Unit Location: Corvallis, Oregon.

2. Research Work Unit Title: Behavior of Chemicals Introduced into the Forest Environment and Their Impact on the Ecosystem (Behavior and Impact of Forest Chemicals).

3. Mission: To solve problems of environmental pollution connected with forest use of chemicals.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	5	0	0	0	0	0	5	0
2	5	0	2	0	0	0	7	0
Total	10		2				12	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Behavior of Chemicals Introduced into the Forest Environment.

a. Published:

Bollen, W. B. 1969. Properties of tree barks in relation to their agricultural utilization. Pacific Northwest Forest & Range Exp. Sta. U.S.D.A. Forest Serv. Res. Pap. PNW-77, 36 pp., illus.

About 5 million tons of tree bark are produced annually as waste from wood-using industries in the Pacific States. Most of this bark is burned, often creating air pollution. Bark has a number of potential uses in agriculture and is chemically and physically adaptable to such beneficial utilization.

Bollen, W. B. and Lu, K. C. 1969. Douglas-fir bark tannin decomposition in two forest soils. Pacific Northwest Forest & Range Exp. Sta. U.S.D.A. Forest Serv. Res. Pap. PNW-85, 12 pp.

Purified Douglas-fir bark tannin equivalent to the amount in a 2-inch bark mulch was added to two widely different soils in the laboratory. About 22 percent of the tannin decomposed in 180 days. Soil microflora generally increased. Nitrate production was slightly decreased in the presence of tannins. Douglas-fir bark added to soil appears harmless from the standpoint of its tannin content.

Li, C. Y., Lu, K. C., Nelson, E. E., Bollen, W. B. and Trappe, J. M. 1969. Effect of phenolic and other compounds on growth of *Poria weirii in vitro*. Microbios 3:305-311.

Twenty-five compounds, widely occurring in nature, were tested individually *in vitro* at 0·5 and 2·0 mM concentrations for effects on two isolates of *Poria weirii* Murr., a serious root pathogen of conifers in western North America. Growth of both isolates was strongly inhibited in media containing coumarin, 4-hydroxycoumarin, or 7-hydroxycoumarin at either concentration, but o-catechol, salicylic acid, benzoic acid, ferulic acid, o-coumaric acid, and phenylacetic acid were inhibitory only at the higher concentration. The remaining compounds either inhibited only one isolate, had no effect, or stimulated growth of the fungus. Presence of significant amounts of the inhibitory compounds in host tissue could account for resistance to *P. weirii* by plants such as *Alnus rubra* Bong.

Moore, D. G., Holcombe, E. E. and Strand, R. F. 1969. Phorate persistence in a forest soil. Northwest Sci. 43(1):40. (Abstr.)

Phorate (O-O-diethyl S-ethylthiomethyl phosphorodithioate), a highly toxic systemic insecticide, was applied broadcast on the forest floor at rates of 1, 10, and 100 pounds per acre. After 18 months, measurable levels of both phorate and its metabolites were still present in the forest floor and soil. At the highest rate of application, the mean total residue was 4.50 pounds per acre.

Norris, Logan A. 1969. Herbicide runoff from forest lands sprayed in summer. *In* Res. Progress Rept., West. Soc. Weed Sci., pp. 24-26.

Phenoxy and picloram herbicides were applied in the summer to small watersheds. Herbicide residues in fall runoff from these lands were greatest when the chemicals were applied in late summer to a high percentage of the watershed and when the first fall storms were of high intensity.

Norris, Logan A. 1969. Some chemical factors influencing the degradation of herbicides in forest floor material. *In* Res. Progress Rept., West. Soc. Weed Sci., pp. 22-24.

The degradation of 2,4-D, 2,4,5-T, and picloram in forest floor material was not influenced by pretreatment with certain other pesticides. The relative rates of degradation of these herbicides were not influenced by starting concentration.

Norris, Logan A. 1969. Degradation of several herbicides in red alder forest floor material. *In* Res. Progress Rept., West. Soc. Weed Sci., pp. 21-22.

Amitrole, 2,4-D, 2,4,5-T, and picloram are degraded in forest floor material but at markedly different rates. Picloram was most persistent, followed in order by 2,4,5-T, amitrole, and 2,4-D.

Norris, Logan A. and Morris, Roy O. 1969. Protein metabolism as influenced by growth regulator chemicals in plants. *In* Res. Progress Rept., West. Soc. Weed Sci., pp. 103-104.

Primary root elongation was inhibited and abnormal lateral root proliferation was observed in 2-day-old pea seedlings treated with 2,4-D, picloram, NAA, or IAA. Extracts from seedling roots 2 days after chemical treatment contained at least two proteins not found in untreated seedling roots.

Norris, L. A. and Morris, R. O. 1969. Qualitative changes in cytoplasmic proteins in plants treated with growth regulating chemicals. Abstr. *In* Abstracts of Papers, XI Int. Botanical Congr. p. 160.

A soluble cytoplasmic protein associated with zones of meristematic activity or tissue expansion has been found in roots of pea seedlings. A method to isolate this protein by ammonium sulfate fractionation and preparative scale gel electrophoresis has been developed.

Tarrant, R. F., Moore, D. G. and Bollen, W. B. 1969. DDT residues in forest floor and soil after aerial spraying. (Abstr.) Amer. Soc. Agron. Abstrs. 1969:126.

Total DDT in the forest floor, surface mineral soil, and litterfall, and in throughfall precipitation was measured over a 3-year period after an operational aerial spraying in eastern Oregon. Of the 0.84 kg/ha DDT initially applied, 26 percent reached the forest floor immediately. An additional 6 percent was brought down in litterfall over a 3-year period. DDT in throughfall precipitation over 3 years totaled less than 0.2 percent of the original application. Total DDT declined from a maximum of 0.22 kg/ha in the forest floor immediately after spraying to 0.10 kg/ha after 3 years. No appreciable movement of DDT from forest floor to mineral soil was observed.

Tu, C. M. and Bollen, W. B. 1969. Effect of Tordon herbicides on microbial activities in three Willamette Valley soils. Down to Earth 25(2):15-17.

Picloram, potassium salt solution, at rates of 1 and 10 p.p.m. acid equivalent, had no significant effect on microbial activities in three soils of differing characteristics.

b. Unpublished: None

Problem No. 2--Impact of Introduced Chemicals on Major Elements of the Forest Ecosystem.

a. Published:

Bollen, Walter B. 1967. The soil as a biological system and its ecological significance. *In* Proc. Nat. Acad. Sci., India. 37(A), III & IV. 1967: 381-390.

Describes the ecological significance of soil microbes.

Bollen, W. B., Lu, K. C., Trappe, J. M. and Tarrant, R. F. 1969. Influence of Sitka alder on soil formation and microbiological succession on a landslide of alpine origin at Mount Rainier. Pacific Northwest Forest & Range Exp. Sta. U.S.D.A. Forest Serv. Res. Note PNW-103, 5 pp.

A Sitka alder seedling, growing on 5-year-old avalanche debris below Mount Rainier, led to increased soil carbon and nitrogen and increased microbial populations over a 3-year period. Over 5 years, avalanche debris decreased in pH from moderately alkaline to slightly acid, and the "soil" surface had become somewhat more consolidated.

Li, C. Y., Lu, K. C., Trappe, J. M. and Bollen, W. B. 1969. A simple, quantitative method of assaying soil for inhibitory fungi. Soil Biology, N.S. No. 10. Int. News Bull., Int. Soc. Soil Sci., Commission III, Paris. pp. 6-7. Also republished as Pacific Northwest Forest & Range Exp. Sta. U.S.D.A. Forest Serv. Res. Note PNW-108, 3 pp., illus.

Micro-organisms isolated from soil can be easily tested for inhibition of root pathogens such as *Poria weirii*. The isolates are transferred by toothpick probes to the surface of a double-layered agar plate containing pathogen mycelium sandwiched between the agar layers. The pathogen does not grow under inhibitory organisms.

Montgomery, Marvin L. and Norris, Logan A. 1970. A preliminary evaluation of the hazards of 2,4,5-T in the forest environment. Pacific Northwest Forest & Range Exp. Sta. U.S.D.A. Forest Serv. Res. Note PNW-116, 9 pp.

2,4,5-T is low in acute toxicity, does not persist for long periods in the soil or vegetation, and is rapidly excreted by animals. The hazard of 2,4,5-T in the forest environment is low when used according to tested procedures.

Ricard, J. L., Wilson, M. M. and Bollen, W. B. 1969. Biological control of decay in Douglas-fir poles. Forest Prod. J. 19(8):41-45.

Douglas-fir poles containing incipient decay in heartwood near the ground line were inoculated with a fungus, *Scytalidium* sp. FY strain, which does not weaken wood, to learn whether this fungus would become established and inhibit growth of *Poria carbonica*, a prevalent rot. The FY strain did not become established in 50 poles. Where its growth was followed closely in one pole, viable *P. carbonica* disappeared from the wood as it was penetrated by the FY strain. Wood in which the FY strain had been killed by steaming had an inhibitory influence on subsequent

inoculations of *Poria carbonica*. These results show promise for the eventual goal of developing biological control of rot in poles in service.

Tarrant, Robert F., Lu, K. C., Bollen, W. B. and Franklin, J. F. 1969. Nitrogen enrichment of two forest ecosystems by red alder (*Alnus rubra*). Pacific Northwest Forest & Range Exp. Sta. U.S.D.A. Forest Serv. Res. Pap. PNW-76, 8 pp.

In a coastal Oregon area, where soil nitrogen is perhaps near the maximum attainable in a forest environment, presence of red alder led to a threefold increase in the amount of nitrogen circulating in litterfall.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem 1--Behavior of Chemicals Introduced into the Forest Environment.

a. New Studies:

Distribution and fate of herbicide metabolites.

b. Manuscripts:

Persistence of phorate in a forest environment (Study No. P7--Pesticides Monitoring Journal).

Biological degradation of herbicides in forest litter (Study No. P9--Proceedings of the Third North American Forest Soils Conference).

A nitrite reducing, non-nitrate reducing bacterium isolated from a marine sediment (Study No. P5--Canadian Journal of Microbiology).

Enzymatic versus nonenzymatic denitrification (Study No. P1--Journal of Applied Microbiology).

DDT in precipitation of a forested area in Oregon (Study No. P8--Pesticides Monitoring Journal).

Amount and movement of DDT in a forest ecosystem after aerial spraying (Study No. P3--Pesticides Monitoring Journal).

DDT in forest soils of western Oregon (Study No. P3--Northwest Science).

Nonbiological reduction of nitrite in soil (Study No. P5--Nature).

Adsorption and desorption of four herbicides on forest floor material (Study No. P9--Northwest Science).

The kinetics of adsorption and desorption of 2,4-D, 2,4,5-T, picloram, and amitrole on forest floor material (Study No. P9--Western Society of Weed Science Progress Reports).

Herbicide degradation in forest litter (Study No. P9--Down to Earth).

Herbicide runoff after first fall rains (Study No. P9--Down to Earth).

The behavior of pesticides in plants (Study No. P9--Proceedings of the Symposium on Microchemicals, Oregon State University).

Problem 2--Impact of Introduced Chemicals on Major Elements of the Forest Ecosystem.

a. New Studies:

Nutrient content of streamwater after forest fertilization. *

Effect of stabilized pyrethrum on soil microbial activity.

b. Manuscripts:

Influence of Endrin on soil microbial activities (Study No. P9--Station Research Note).

Effect of phenolic compounds on growth of *Poria weirii in vitro* (Study No. P1--Canadian Journal of Microbiology).

Effect of Tordon on microbial activities in three Willamette Valley soils (Study No. P9--Down to Earth).

Inhibition of *Poria weirii* and *Fomes annosus* by linoleic acid (Study No. P1--Forest Science).

Environmental consequences of using fertilizer and other chemicals in forest management (Study No. P1--Proceedings of the 1969 Western Forestry and Conservation Association).

Protein metabolism as influenced by growth regulator chemicals in plants (Study No. P9--Western Society of Weed Science Research Progress Reports).

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1701 for Year Ending
March 31, 1970

1. Research Work Unit Location: La Grande, Oregon

2. Research Work Unit Title: Ecology and Management of Forest and Related Ranges in the Pacific Northwest. (Range Environmental Management--NW.)

3. Mission: To develop ecological information basic to environmental management of forested and related ranges for development of forage resources and for harmonizing its use with management of other resources.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	3	0	2	0	0	0	4	1
2	13	0	0	0	0	0	12	1
3	1	0	2	0	0	0	3	0
Total	17	0	4	0	0	0	19	2

5. Accomplishments for Each Selected Problem:

Problem No. 1--Ecosystem Description and Site Potential Determinations of Conifer Forested Ranges.

a. Published:

Reuss, John O., and J. Michael Geist. 1969. Predictions of nitrogen fertilizer requirements of field crops. I. Theoretical models of nitrogen release. Agron. Abstr. 1969. p. 100.

Applicability of this study's findings, with some modifications, includes forest and range crops as well as farm crops, since it deals with theory and principles of the nutrient nitrogen's availability in the soil for plant growth. Theoretical mathematical models of the regression type were produced for prediction of certain plant development parameters as related to total supply of available mineral nitrogen. The primary models and some variations on them took into account the available nitrogen in the fertilizer fraction, that of the mineral soil, and that released by organic matter.

There are 8 million acres of mixed-conifer forest and range type in eastern Oregon and eastern Washington to which the developed theory and principles would apply, with adjustments for the plant and stand characteristics desired. It is estimated that intensified silvicultural practices of a physical nature could double production of the plant community, and with the addition of the right kind and amount of fertilizer, the production of these stands might be tripled and thus achieve high-yield forest and range environment.

Geist, J. Michael, John O. Reuss, and Donal D. Johnson. 1969. Prediction of nitrogen fertilizer requirements of field crops. II. Application of theoretical models to malting barley. Agron. Abstr. 1969. p. 95.

As with the study above, this one is with some modification applicable to general theory and principles of soil and plant nutrition of forest and range lands. Three mathematical models involving availability of organic, soil, and fertilizer nitrogen were experimentally used in the prediction of plant yield, seed protein content, and seed protein nitrogen. Two of the models showed improved predictability of certain plant developmental characteristics. One of the regression equation models was advantageous over others in studying the relative contribution of organic nitrogen to plant production. Procedures involved in this work will in many respects be usable in further studies of forest and range nutrition, particularly in the mixed-conifer ecosystem of eastern Oregon and eastern Washington.

b. Unpublished: None.

Problem No. 2--Development of Management Systems for Integration of Range, Timber, Wildlife, and Recreation.

a. Published:

Skovlin, Jon M., and Robert W. Harris. 1970. Management of conifer woodland grazing resources for cattle, deer, and elk. In Proceedings of XI International Grassland Congress. Section on natural grasslands, woodlands and shrublands. pp. 75-78.

In a study comparing season-long and deferred-rotation grazing at three intensities of cattle stocking, it was determined deferred-rotation grazing in ponderosa pine forest at the light rate of stocking was the only management treatment providing significant herbage production improvement. Big game animals also used the area seasonally, and although deer and elk use accounted for 25 percent of the total herbage removed, they did not make much use of forage important to cattle. However, it was found that as cattle stocking increased elk use decreased. Deer were less sensitive to grazing pressure by cattle.

Demands upon the 12 million acres of pine forest in eastern Oregon and eastern Washington are great. Presently, this summer range is only accommodating half the livestock numbers that can be supplied forage at other seasons of the year off the forest. There are pressures also to sustain elk and deer herds which are among the largest in the nation. Thus managers are challenged to harmonize resource management of conifer woodland for the production of wood, food, water, and outdoor recreation.

b. Unpublished: None

Problem No. 3--Vegetation Management and Rehabilitation of Conifer Forested Ranges.

a. Published: None

b. Unpublished: None

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Ecosystem Description and Site Potential Determinations of Conifer Forested Ranges.

a. New Studies: None

b. Manuscripts:

Prediction of nitrogen fertilizer requirements.

Problem No. 2--Development of Range Management Systems

a. New Studies:

Range and cattle benefits of weaning in August.

b. Manuscripts:

A study of cattle range management (Study R-10 with subunits--Technical Bulletin).

Changes in vegetation and soil cover on Starkey allotment (Study R-6--J. Range Manage.).

Vegetation characteristics of grazed and ungrazed plant communities (Study R-7--J. Range Manage.).

Mobilizable carbohydrate levels of three key forage species (Study R-3--J. Range Manage.).

Grazing reforested clearcuts (Study R-15--Station Research Note).

Monitoring vegetation of Burns tussock moth spray project (Study R-11--Pesticide Monitoring J.).

Problem No. 3--Vegetation Management and Rehabilitation of Conifer Forested Ranges.

a. New Studies:

Effects of a slash crushing method in ponderosa pine type range forage.

Viable seed in litter and surface soils under conifer forests. (A cooperative study between range and wildlife projects.)

b. Manuscripts:

Plant succession on a reseeded subalpine range (Study R-13).

Fertility comparisons of seven soil series occurring in the central Blue Mountains of Oregon by bio-assay (Study R-18).

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Research Work Unit FS-PNW-1801 for Year Ending
March 31, 1970

1. Research Work Unit Location: La Grande, Oregon

2. Research Work Unit Title: Big-game Habitat-Pacific Northwest

3. Mission: To provide a scientific basis for coordinated management of big-game habitat with the many other resources of forest and range lands.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	3	1	0	1	0	0	4	0
2	3	1	0	0	0	0	3	1
3	3	1	1	0	0	1	3	1
4	3	1	0	0	0	1	2	1
Total	12	4	1	1	0	2	12	3

5. Accomplishments for Each Selected Problem:

Problem No. 1--Management of Winter Game Ranges

a. Published:

McConnell, Burt R. and Smith, Justin G. 1970. Frequency distributions of deer and elk pellet groups. J. Wildl. Manage. 34(1): 29-36.

Information on observed frequency distributions has considerable ecological and empirical value in population studies, but few attempts have been made to determine the underlying mathematical models which describe deer and elk pellet group distributions. If the habitat is sufficiently uniform, a close correlation exists between the distribution of deer and elk groups and the Poisson series--a theoretical model describing randomly dispersed populations. In heterogeneous habitats the negative binomial model provided a close approximation of deer and elk pellet group distributions.

McConnell, Burt R., and Smith, Justin G. 1970. Some effects of grazing intensity on bitterbrush dispersion. J. Range Manage. 23(2):92-94.

Three fence-line comparisons were made to determine the effect of grazing intensity on the density and dispersion of bitterbrush (*Purshia tridentata* (Pursh) DC.) in a uniform habitat. Bitterbrush density was reduced by heavy grazing but was not affected by moderate use. The large increases in mean area per plant that occurred under heavy grazing did not alter the overall form of random population dispersion. In a comparison of heavy versus moderate use, inclusion of 1-year-old plants on the moderately grazed area (10% of population) caused aggregation of the population. Even though a larger number of 1-year-old plants (22% of population) occurred in the heavily grazed comparison, the population remained random. The contrasting reaction probably resulted from a differential pattern of seedling mortality due to different amounts of herbaceous understory in the two shrub populations. Observations on the nature and extent of changes in dispersion should be considered with density data in interpreting the dynamics of key forage species in condition and trend work.

Segura, Mariano. 1969. Ecology of bitterbrush in the Silver Lake deer winter range, Oregon. Doctoral thesis; Oregon State University, Corvallis, 342 pp.

Bitterbrush, because of its good palatability and nutritive value and its wide distribution, is a major forage species on western ranges. Understanding the ecology of this important species is essential to its proper management. The objectives of this study were to obtain a more precise phytosociological description of bitterbrush stands, to identify the environmental factors associated with its distribution and abundance, and to elucidate the vegetation-soil relationships of vegetal communities with and without bitterbrush.

Communities were clearly defined by use of species lists with prominence ratings and confirmed by stepwise discriminant function analysis. Shrubs proved to be the best discriminants, forbs second best, and grasses poorest. Elevation was a very good discriminating variable in a combined analysis of environmental factors. The pH range of soils supporting bitterbrush was 6.4-7.0. There was no clear relationship between soil depth and presence or absence of bitterbrush, but it reached its best development on coarse-textured soils. Root development of bitterbrush is extensive and usually much greater than development of the aerial part of the plant. Only 3 of 30 plants excavated showed root nodules.

b. Unpublished: None

Problem No. 2--Forest-Wildlife Relations

a. Published: None

b. Unpublished: None

Problem No. 3--Big Game-Livestock Relations

a. Published: None

b. Unpublished: None

Problem No. 4--Rehabilitation of Game Ranges

a. Published: None

b. Unpublished: None

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Management of Winter Game Ranges

a. New Studies:

Influence of weather factors on elk behavior on winter range. (Correlate wind velocity, barometric pressure, temperature, humidity and solar radiation with elk activity within a tree cover, at the edge of cover, and in an open area.)

b. Manuscripts:

Effect of grazing on age structure and age-forage production relationships in bitterbrush populations (Study No. 10--Ecology Reports).

Seasonal nitrogen accumulations in bitterbrush (Study No. 12--J. Range Manage.).

Grazing intensity and interaction between age and nutrient status in bitterbrush (Study No. 10--J. Range Manage.).

More and better bitterbrush forage through moderate grazing (Study No. 10--Western Livestock J.).

Problem No. 2--Forest-Wildlife Relations

a. New Studies:

Viable seed in litter and surface soils under conifer forests. (Determine kind and amount of seed in uncut areas and relate this to the plant communities developing following logging.)

b. Manuscripts:

Response of understory vegetation to ponderosa pine thinning in eastern Washington (Study No. 21--J. Range Manage.).

Effect of pine needle litter on understory grass (Study WW-9--Station Note).

Early growth and survival of planted ponderosa pine in a clearcut grazed by deer, elk, and cattle (Study No. 20--Station Note).

Cumulative light and temperature values for adjacent clearcut, partial cut, and uncut stands in a mixed conifer forest (Study No. 20--Agri. Meteorol.).

Growing season soil moisture trends in adjacent clearcut, partial cut, and uncut stands in a mixed conifer forest (Study No. 20--Station Note).

Problem No. 3--Big Game-Livestock Relations

a. New Studies: None

b. Manuscripts:

Seasonal diet and habitat use by deer and elk in the central Blue Mountains, Oregon (Study LW-1--J. Range Manage.).

Mule deer-cattle habitat and forage selection with and without competition (Study No. 33--J. Wildl. Manage.).

Problem No. 4--Rehabilitation of Game Ranges

a. New Studies:

Problem analysis. (Comprehensive analysis of all aspects of rehabilitation problems to guide program expansion.)

b. Manuscripts:

Influence of grazing and competing vegetation on survival and growth of planted bitterbrush (Study No. 43--Station Note).

Miscellaneous

Changes in mule deer reproduction associated with herd reduction (J. Wildl. Manage.).

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1901 for Year Ending
April 1, 1970

1. Research Work Unit Location: Seattle, Washington

2. Research Work Unit Title: Wilderness Recreation Dynamics

3. Mission: To conduct and stimulate research on behavioral aspects of wildland recreation to better integrate social and economic values.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1,1969		Changes during year				April 1, 1970	
	Active	In-Active	Begun	Reacti-vated	Com-pleted	Termi-nated	Active	In-active
1	4	1	5	3	4	0	6	0
2	6	2	6	2	3	1	10	0
Total	10	3	11	5	7	1	16	0

5. Accomplishments for Each Selected Problem:

Problem No. 1--Patterns of Recreation Use & Behavior

a. Published:

Burke, Hubert D. 1969. Wilderness engenders new management traditions. The Living Wilderness 33(106):9-13, illus.

Administrators will find wilderness land use objectives, time factors, public relations situations, scope of work, professional attitudes, traditions, and even the meaning of commonly used words to be different from and sometimes directly opposite to those words as applied to management of other public lands. Forest Administration and Research are working on three pilot areas in the Pacific Northwest to develop sound wilderness management procedures. Information related in this article is now incorporated into wilderness management policies in the Pacific Northwest.

Campbell, Frederick L., Hendee, John C., and Clark, Roger. 1969. You can preserve law and order in the parks. Better Camping 10(6): 36-40, illus. June.

The character and incidence of theft, vandalism, litter, and rule violation and underlying causes are reviewed. Greater personal responsibility on the part of all campers in necessary for solution of these growing problems. Alerts managers and campers to some neglected aspects of recreation behavior that need more attention.

Hendee, John C., and Campbell, Frederick L. 1969. Social aspects of outdoor recreation--the developed campground. Trends in Parks and Recreation, October. pp. 13-16, illus.

Highly developed campgrounds attract more social than environment oriented use. Social benefits of modern camping are reviewed and suggestions offered to managers. Highly developed playgrounds should be accessible and sites off the beaten track reserved for environment-oriented recreation use. The planning method for coordinating multiple uses reported in this manuscript offers possibilities for greater simultaneous satisfaction of several resource user needs from the same large unit of land.

Hendee, John C. 1969. Appreciative versus consumptive uses of wildlife refuges: studies of who gets what and trends in use. Transactions of the Thirty-Fourth North Amer. Wildlife and Natural Resources Conf., March 2-5, 1969, Wash., D.C.

Appreciative versus consumptive (hunting and fishing) types of recreation are compared as to (1) who participates in the two types of use, (2) what intangible benefits are gained, (3) what are trends in participation. Such information is vital to policy decisions where trade-offs between the two types of use must be made.

b. Unpublished:

None

Problem No. 2--Recreation Values, Motivation & Quality.

a. Published:

Catton, William R., Jr. 1969. Motivations of wilderness users. Pulp & Paper Magazine of Canada WS Index 2528 (F3) ODC 907.2, pp. 121-126. Dec. 19.

Factual data on characteristics and behavior of wilderness users and other forest recreationists provides a basis for inferences about their motivations. This article draws on data from several studies of wilderness users and merges their implications.

Harry, Joseph, Gale, Richard, and Hendee, John 1969. Conservation--an upper-middle class social movement. J. Leisure Res. 1(3): 246-254. Summer 1969.

Suggests that conservationists frequently belong to a very large number of voluntary associations and appear to isolate themselves structurally by concentrating their civic activities in the conservation field. Suggests a possible reason for restricted diffusion of conservation values in society.

Hendee, John C., Gale, Richard P., and Harry, Joseph. 1969. Conservation, politics, and democracy. J. Soil and Water Conserv. 24(6): 212-215, illus. November-December 1969.

A growing chasm exists between "wise use" conservationists and those holding "preservationist" philosophies. The number and growth of conservation-preservation groups, the characteristics and representativeness of members are discussed. Uses data to project the number of conservationists affiliated with formal organizations.

Hendee, John C. 1969. Rural-urban differences reflected in outdoor recreation participation. J. Leisure Research. 1(4): 333-341, illus. Autumn, 1969.

Differences were small compared to other demographic variables such as age, socio-economic status, etc., and suggest that theories may be more appropriately built around demographic factors other than residence.

b. Unpublished: None

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Patterns of Recreation Use and Behavior.

a. New studies:

Manager perception of recreation behavior problems.

Participant observation as a tool in recreation research.

Recreational values, use, and management of natural areas.

Social and behavioral aspects of hunting--an annotated bibliography.

b. Manuscripts:

Design, construction, and use of questionnaires for recreation research.

An annotated bibliography on questionnaire construction.

Managers perception of wilderness user attitudes and preferences.

Corporate forest recreation: How much and why.

Problem No. 2--Recreation Values, Motivation & Quality.

a. New studies:

The folklore of environmental education.

Sociological criteria for public resource allocation.

Occupational influences on environmental attitudes.

Environmental attitudes and knowledge of sixth grade school children.

Experimental control of littering.

Manager perception of recreation behavior problems.

b. Manuscripts:

Foresters perception of special interest group positions on forest policy.

The Eugene Ladies Outdoor Recreation Education Program and Attitude Change.

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1902 for Year Ending
March 31, 1970

1. Research Work Unit Location: Seattle, Washington.

2. Research Work Unit Title: Cooperative Recreation Research.

3. Mission: This is two-fold: (a) to increase the supply of people with postgraduate education that prepares them for research or administration in outdoor recreation, (b) to provide improved procedures for maintaining or increasing the quality of recreation experiences for the growing number of visitors to outdoor recreation areas.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated 1/	Active	Inactive
1 2/	2	0	2	0	0	0	4	0
2	(1)	0	1 +(1)	0	0	0	1+(2)	0
3	0	0	0	0	0	0	0	0
4	(1)	0	(1)	0	0	0	(2)	0
Total 2/	2	0	3	0	0	0	5	0

1/ Studies that have been stopped before completion with no intention of reactivation.

2/ Studies listed opposite problem No. 1 (Graduate Education in Outdoor Recreation) are also shown opposite the problem numbers that indicate the subject areas investigated. Numbers in parentheses are used for these studies to avoid double counting in the total.

5. Accomplishments for Each Selected Problem:

Problem No. 1--Graduate Education for Outdoor Recreation.

a. Published:

Wagar, J. Alan. 1970. Review of "Forest Recreation by Robert W. Douglass. J. Forestry 68(1):30.

b. Unpublished:

The master's thesis "A comparison of four techniques for inventorying man-made impacts along roadways" was completed by Dale R. Potter under the Project Leader's direction. For a forested valley this showed that visual impacts on the landscape could be inventoried from an automobile for $1.87 per mile. An office inventory using 1:20,000 aerial photos cost $1.35 per mile, provided less complete information, and did not show which impacts were visible from the roadway.

Five hundred and fifty-two usable interviews were taken with visitors to interpretive facilities at 4 visitor centers. Data have been coded, keypunched, and partially analyzed to determine what subject matter, stimuli, and communication strategies are most effective for holding visitor attention and transmitting information.

Graduate student Michimasa Kojima developed two computer programs that generate perspective drawings of the landscape as it would appear from selected points. One program includes vegetation symbols drawn to scale. The programs can aid planners in visualizing the effects of landscape changes before they are made.

A research nature trail has been established on the University of Washington's Lee Forest. Arrangements have been made with Cathcart elementary school to use 6th, 7th, and 8th grade students for testing the effectiveness of 3 kinds of interpretive signing.

Problem No. 2--Procedures for Interpretation.

a. Published:

None

b. Unpublished:

A response-counting quizboard was built and tested. This indicates the effectiveness of interpretive exhibits by recording the proportion of correct responses to questions about nearby exhibits.

Tentative conclusions are: (1) animals are of greater interest to park visitors than plants, (2) audio messages are remembered better than printed labels, (3) facts are remembered better than concepts, (4) information illustrated with specimens and models is remembered better than that illustrated by still pictures, and (5) children like something they can manipulate.

Other accomplishments are listed under Problem No. 1.

Problem No. 3.--Maintaining Soils and Vegetation.

a. Published:

None

b. Unpublished:

None

Problem No. 4.--Coordinating Recreation and Other Land Uses.

a. Published:

WAGAR, J. ALAN. 1969. Nonconsumptive uses of the coniferous forest with special relation to consumptive uses. Pp. 255-270 in Coniferous Forests of the Northern Rocky Mountains. University of Montana Foundation. Missoula.

b. Unpublished:

Described under Problem No. 1.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Graduate Education for Outdoor Recreation.

a. New Studies:

A test of "preprograming" visitors for increasing effectiveness of interpretation (tentative).

b. Manuscripts:

A comparison of four techniques for inventorying man-made impacts along roadways (Station Paper)

Computer generated drawings of groundform and vegetation: an aid to visual management of large landscapes (Landscape Architecture)

Problem No. 2--Procedures for Interpretation.

a. New Studies:

Effectiveness of interpretation provided for salmon fishermen on Russian River, Alaska (tentative).

b. Manuscripts:

The challenge of environmental education (Today's Education).

Problem No. 3--Maintaining Soils and Vegetation.

a. New Studies:

None

b. Manuscripts:

None

Problem No. 4--Coordination of Recreation Opportunities

a. New Studies:

None

b. Manuscripts:

Growth versus the quality of life (accepted by Science)

A conceptual framework for outdoor recreation planning and management (Station Paper).

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-2103 for Year Ending March 31, 1970

1. Research Work Unit Location: Seattle, Washington

2. Research Work Unit Title: Fuel Appraisal

3. Mission: To develop a universal system for describing wild-land fuels in a manner that will permit quantitative correlation between fuel description and fire behavior.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem No.	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated[1/]	Active	Inactive
1	3	0	2	0	2		3	0
2	2	0	1	0	0	0	3	0
3	Not activated							
Total	5		3		2		6	

1/ Stopped before completion; not to be reactivated.

5. Accomplishments for Each Selected Problem:

Problem No. 1--Description and measurement of fuels

a. Published:

Fahnestock, G. R. 1970. Dichotomous keys for appraising forest fire fuels. Northwest Sci. 44(1): 61,62. (Abstract)

A glossary and experimental key provide a common frame of reference that has enabled a number of observers to evaluate potential rate of fire spread consistently in five geographic regions of the United States. The key will be valuable for training, scouting fires, inventorying fuels, and coordinating regional fuel types, and showing impacts of resource management on fire protection. (More detailed treatment in process; see 6, b.).

b. Unpublished: None

Problem No. 2--Fuel Mapping and Reconnaissance

a. Published:

Lund, H. G. 1969. Appraising and mapping fuels with aerial photographs. Am. Soc. Photogram./Am. Cong. Surv. Map. Proc. 173-180, Portland, Ore.

Information on the kind, quantity, arrangement, and location of fuels is prerequisite to planning and executing effective, scientific forest fire protection. Height and perhaps other characteristics of understory vegetation can be measured with acceptable accuracy on 1:8,000, natural-color, aerial photography. Feasibility of mapping fuel types on aerial photos is being tested. Photography from earth-orbital satellites may be suitable for small-scale mapping of major fuel categories. Varied research is needed to determine the best means of gathering fuel intelligence for various purposes and in diverse situations.

b. Unpublished: None

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Description and Measurement of Fuels:

a. New studies:

Catalog of available fuel information by phenotype.

b. Manuscripts:

Two keys for appraising forest fire fuels (Study FA-1.4--Forest Service Research Paper PNW-99, in press)

Weight of brushy forest fire fuels from photographs (Submitted to Forest Science)

Effects of slash-burning in overmature stands in the Douglas-fir region (Accepted by Forest Science)

Photo inventory of fine logging slash (Study FA-1.1--Submitted to Photogrammetric Engineering)

Color response of vegetation to drought (Study FA-1.2--Forest Service Research Note)

Fuels from precommercial thinning of Douglas-fir and hemlock in the Pacific Northwest (Study FA-1.5--Forest Service Research Paper)

Problem No. 2--Fuel Mapping and Reconnaissance

a. New studies:

Inventory and evaluation of logging slash fuels on large-scale aerial photographs

b. Manuscripts:

Characterizing understory vegetation in hardwood stands from aerial photographs (Studies FA-2.2 and FA-2.3--Photogrammetric Engineering or Forest Service Research Paper)

Mapping New Jersey Pine Barrens fuels from aerial photography (Study FA-2.4--Journal of Forestry)

Line-intercept inventory versus fuel-key rating of logging slash fuels on large-scale aerial photographs. (Study FA-2.6--Forest Service Research Note)

A parallax wedge for use with mirror stereoscope (Photogrammetric Engineering)

Problem No. 3--Development of Operational Fuel Appraisal Systems

a. New studies:

Problem analysis

Conversion of regional fuel types to a national value scale

b. Manuscripts:

A national scale for regional fuel types (Study FA-3.1--Forest Service Research Note)

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-2105 for Year Ending March 31, 1970

1. Research Work Unit Location: Seattle, Washington

2. Research Work Unit Title: Forest Fire Science

3. Mission: (a) To develop graduate programs in forest fire science and technology, (b) to train graduate students in forest fire science and technology, (c) to perform cooperative research with students and faculty at the University of Washington.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem No.	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated1/	Active	Inactive
1	1	0	0	0	0	0	1	0
2	1	0	0	0	0	0	1	0
3	0	0	1	0	0	0	1	0
4	1	0	0	0	1	0	0	0
5	3	0	1	0	2	0	2	0
Total	6		2		3		5	

1/ Studies that have been stopped before completion with no intention of reactivation

5. Accomplishments for Each Selected Problem:

Problem No. 1--Development of Graduate Programs and Courses in Forest Fire Science and Technology

a. Published:

University of Washington. 1970. Official University Course Catalog, 1970-71. University of Washington Press: 468 pp., illus.

University of Washington: Graduate Study in the College of Forest Resources. 1970. University of Washington Press: 45 pp., illus.

Graduate programs in forest fire science and technology at the University of Washington are described.

Master of Forestry - A program structured for forest fire control managers.

Master of Science and PhD programs - for forest fire scientists.

Options described are:

Forest fire prevention - Interdisciplinary between the College of Forest Resources and Sociology Department.

Forest fire economics.

Forest fire physics and behavior.

Forest fire meteorology - Interdisciplinary, College of Forest Resources and Atmospheric Sciences.

Forest fires and atmospheric pollution - Interdisciplinary, College of Forest Resources and College of Civil Engineering.

Prescribed fire and forest land management.

Courses developed for the forest fire science and technology program are described:

Elementary forest fire science and technology.

Forest fire management.

Forest fire thermophysics.

Forest fire behavior.

Seminar in forest fire science.

Forest fire influences.

b. Unpublished: none

Problem No. 2--Forest Fire Control Economics

a. Published: None

b. Unpublished: None

Problem No. 3--Forest Fires and Atmospheric Pollution

a. Published:

Fritschen, Leo J. and Pickford, Stewart G. 1969. Research and development - air quality. Bull Springs prescribed burning project. The Bull Springs study: techniques and preliminary results. Proc. NW Forest Fire Counc., Oct. 29-30, 1969.

Bovee, H. H. 1969. Research and development - air quality. Bull Springs prescribed burning project. Chemical emissions: particulate and gaseous. Proc. NW Forest Fire Counc., Oct. 29-30, 1969.

Murphy, James L. 1969. Research and development - air quality. Bull Springs prescribed burning project. The study and the meaning of the preliminary results to forest managers. Proc. NW Forest Fire Counc., Oct. 29-30, 1969.

Murphy, Jim. 1969. Research and development air quality. Proc. NW Forest Fire Counc., Oct. 29-30, 1969: 47-48.

Nichols, Earl. 1969. Research and development - air quality. Bull Springs prescribed burning project. Proc. NW Forest Fire Counc., Oct. 29-30, 1969: 49-51.

Laboratory tests have shown certain fire retardant chemicals may decrease the threat of air quality impairment from slash burning. Large scale field tests in Eastern Oregon ponderosa pine slash showed that diammonium phosphate, when sprayed on slash to be burned, causes less total fuel reduction, greater particulate production, and higher levels of some undesirable chemical compounds than slash that was untreated.

Large scale field research projects today require the utmost in cooperative effort. Interdisciplinary scientific teams are needed, and the advice and support of professional and technical managers and crews is vital. The Bull Springs research project team consisted of scientists and technicians from five different colleges or departments at the University of Washington and the University of California at Riverside, scientists and technicians and crews from two Experiment Stations, three National Forests, and two other units of National Forest Administration, all of the U.S. Forest Service, State Forester, State of Oregon, and scientists from the Monsanto Company, Cincinatti, Ohio. At least $30,000 of the cost of the field portion of the research project was contributed.

b. Unpublished: None

Problem No. 4--Evaluation of Forest Fire Control Programs, Plans, Research Programs, and Education

a. Published:

Murphy, James L. 1968. Una evaluacion preliminar del problema de incendios forestales en la Republica de Chile y del plan nacional de proteccion contra incendios forestales. Instituto Forestal Chile: 24 pp. (In Spanish)

A 2-year drought has caused a serious forest fire hazard in the Republic of Chile. A Department of Protection has recently been established under the Minister of Agriculture and has as its primary responsibility the planning and administration of forest fire control programs. The program, as prepared by the Forest Protection Division, is assessed to be well thought out, comprehensive, and demonstrates a high degree of competence by forest engineers who prepared it. Forest fire risk, hazard, and damage potential appear to be increasing in Chile. Damage potential in particular is increasing because of the movement of people, houses, villages, and towns into the forested areas where they become part of the overall "combustibles." Nineteen recommendations and a three-phase priority action program for implementation of the proposals are presented. Various fire attack systems were analyzed and evaluated for use in the Chilean program. It was estimated that a fleet of six air tankers, as proposed by the Chilean Government for forest fire control, would cost the Republic, annually, 60 million escudos. This is approximately equivalent to $6 million annually.

b. Unpublished:

Progress in forest fire control and research in the Republic of Chile.

United States Peace Corps volunteers have helped bring effective fire prevention programs and helped to organize and train fire crews in the Republic of Chile. Five separate research projects are underway at the University of Chile and University Austral investigating fire control problems.

Problem No. 5--Prescribed Fire as a Tool of Forest Management

a. Published:

Murphy, James L., Philpot, Charles W., and Garber, Morris J. 1969. The effect of asphalt and wax emulsions on moisture changes in slash. U.S.D.A. Forest Serv. Res. Pap. PNW-81: 14 pp., illus.

Protective spray on slash coatings has been proposed and tried experimentally to help keep slash dry until safe conditions for burning exist. A laboratory test was carried out to determine the relative effectiveness of five different slash coatings including asphalt and wax emulsions on moisture changes in slash. Ponderosa pine slash was used to test the effect of mixing ratios, shading, and rainfall on the coatings and controls. Significant differences were found between some of the coatings in both the retardation of drying in green slash and the moisture uptake by dry slash. Mixing ratios and shadings made the greatest differences in drying rates and little differences in protection effectiveness. Future field study is needed to create guidelines for the use of slash coating.

b. Unpublished: None

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Development of Graduate Programs and Courses in Forest Fire Science and Technology

a. New Studies: None

b. Manuscripts:

(Training forest fire control managers and forest fire scientists. To be submitted to the Journal of Forestry)

Problem No. 2--Forest Fire Control Economics

a. New Studies: None

B. Manuscripts:

How good are fire control objectives (To be submitted to the Journal of Forestry)

Technically and economically justified objectives for forest fire control.

Problem No. 3--Forest Fires and Atmospheric Pollution

a. New Studies:

Frequency distributions of atmospheric profiles associated with air pollution from burning in the Puget Sound forests.

A study of the air pollution potential from burning slash treated with selected fire accelerants.

b. Manuscripts:

The effect of selected fire retardants on slash burning and air pollution potential.

Forest burning and air quality: the forest manager's newest challenge (Submitted to Western Conservation Journal)

Research looks at forest burning and air quality (Submitted to Journal of Forestry)

Slash burning and air quality: a new challenge to the forest fireman (Submitted to Fire Control Notes)

The burning of forest fuels and air quality (In proceedings of Southwest Interagency Forest Fire Council Annual Meeting)

Scientific slash burning to minimize the threat of air pollution (In proceedings of Southwest Interagency Forest Fire Council Annual Meeting)

Problem No. 4--Evaluation of Forest Fire Control Programs, Plans, Research Programs, and Education

a. New Studies: None

b. Manuscripts:

A study of slash burning policies and practices on the Queets Indian Reservation, Washington.

Problem No. 5--Prescribed Fire as a Tool of Forest Management

a. New Studies:

The use of fire as a silvicultural tool when managing second-growth Douglas-fir under the shelterwood system

b. Manuscripts:

The contribution of selected fuel boosters to the combustion of slash under marginal burning conditions

Factors affecting combustion of slash during marginal burning conditions

Prescription for slash burning in the Pacific Northwest: a statistical analysis (To be submitted as Station research paper)

Problem No. 6--Miscellaneous

a. New Studies: None

b. Manuscripts:

Production and cost of a high lead logging experiment (To be submitted to Journal of Forestry and a trade journal)

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-2201 for Year Ending March 31, 1970

1. Research Work Unit Location: Corvallis, Oregon

2. Research Work Unit Title: Forest Insect Biology and Ecology

3. Mission: To study the biology and ecology of important forest insects in the Pacific Northwest; and to develop biologically and economically sound and effective means for preventing or reducing damage.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	In-active	Begun	Reacti-vated	Com-pleted	Termin-ated1/	Active	In-active
1	4	0	0	0	0	0	4	0
2	3	0	0	0	0	0	3	0
3	2	1	0	0	0	0	2	1
4	3	0	0	0	1	0	2	0
5	3	0	0	0	1	0	2	0
6	0	1	0	0	0	0	0	1
Total	15	2			2		13	2

1/ Studies that have been stopped before completion with no intention of reactivation.

5. Accomplishments for Each Selected Problem:

Problem No. 1--Bark Beetles.

a. Published:

Mason, Richard R. 1969. Behavior of Ips populations after summer thinning in a loblolly pine plantation. Forest Sci. 15(4): 390-398, illus.

In a study in southeastern Tennessee it was found that summer thinning attracted large numbers of Ips avulsus (Eichh.) and Ips grandicollis (Eichh.) to the residual stand. However, the beetles did not attack living trees, but invaded fresh slash only. Newly emerged brood, instead of accumulating in the old thinning, dispersed to new sources of attractions outside of the thinned areas. It was concluded that slash from summer thinnings in the Southeast may sometimes be a hazard to old or low vigor trees, but is unlikely to be a serious threat to healthy pulpwood stands.

Problem No. 2--Defoliators.

a. Published:

Mason, Richard R. 1969. Sequential sampling of Douglas-fir tussock moth populations. USDA Forest Serv. Res. Note PNW-102, 11 pp., illus.

Sequential plans were constructed for sampling eggs and larvae of the Douglas-fir tussock moth. The plans are a standardized method for making quick ground surveys of incipient outbreaks. They were designed for distinguishing currently innocuous populations from those having outbreak potential.

Tigner, Timothy C. 1970. Resistance to a needle miner in lodgepole pine. PhD Thesis, University of Michigan, Ann Arbor. 79 pp., illus.

Host tree and site relationships were investigated in an outbreak of a lodgepole needle miner in Central Oregon. In field caging studies and laboratory preference tests it was found that foliage from different sources varied significantly in susceptibility to attack. Circumstantial evidence indicated that high tree resistance was associated with poorly drained, moist sites. However, expected differences in tree moisture stress between susceptible and resistant trees could not be confirmed from measurements of xylem water potential.

Certain volatile leaf oils were more common in resistant foliage than susceptible foliage. A number of environmental factors not yet investigated might contribute to the differences in synthesis of these oils.

Wickman, B. E., and R. H. Hunt. 1969. Biology of the phantom hemlock looper on Douglas-fir in California. Jour. Econ. Entomol. 62: 1046-1050, illus.

The first known outbreak of this insect in California occurred near McCloud in 1965. Larval feeding caused heavy defoliation. Patches of understory reproduction and sapling-sized trees were killed outright; pole-sized trees and mature timber suffered top damage and reduced radial growth. The insect has a one year life cycle, overwintering in the egg stage on Douglas-fir needles. The causes of the outbreak were not determined, but the area did have subnormal precipitation in 1964 and 1965. The decline of the outbreak was primarily due to a polyhedrosis virus which drastically reduced looper populations within one year.

b. Unpublished:

A new stabilized formulation of pyrethrins was field tested against larvae of the western hemlock looper. The test demonstrated that the stabilized pyrethrins could be extremely effective against the looper when sprayed from a helicopter. Initial knockdown and ultimate mortality of larvae seemed to be influenced markedly by the degree of direct exposure the insect had to the insecticide at the time of spraying.

Problem No. 3--Sucking Insects.

a. Published: none

b. Unpublished: none

Problem No. 4--Regeneration Insects.

a. Published:

Mitchell, R. G., and W. P. Nagel. 1969. Tree selection for controlling midges on Douglas-fir. American Christmas Tree Journal. 13(4): 11-13.

Results of this study were reported in the unpublished section of last year's report.

Problem No. 5--Insect Impact.

a. Published: None

b. Unpublished: None

Problem No. 6--Forest Product Insects.

a. Published:

Wickman, B. E. A crossbreeding study of the cedar tree borer, Semanotus ligneus amplus, and the fir tree borer, S. litligiosus. Pan-Pacific Entomol. 45: 282-285.

A laboratory breeding study found that these two species will crossmate and females of reciprocal crosses produce viable eggs. However, due to uncontrollable high temperatures all larvae died before the study was completed.

Wickman, B. E. 1969. Wood borers attracted to turpentine in a stand of windthrown timber in northern California. USDA Forest Serv. Res. Note PSW-195, 4 pp., illus.

The attraction of turpentine to wood borers under natural conditions was observed by setting up a series of three types of traps in a stand of windthrown timber. Several species of wood borers and their predators were caught more consistently in downwind traps than in upwind traps suggesting the attraction of turpentine. The wire-mesh traps proved to be the more efficient type of trap. Turpentine or its volatile components might be useful for sampling or possibly controlling certain wood borer populations.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Bark Beetles.

a. New Studies: None

b. Manuscripts:

Sartwell, C., R. F. Schmitz, and W. J. Buckhorn. 1970 Pine engraver in the Western United States. (Study No.--None. U.S.D.A. Forest Pest Leaflet).

Sartwell, C. Tree killing by mountain pine beetle in the natural control of ponderosa pine stand density. (Study No.--None. Canadian Entomologist).

Sartwell, C. Thinning ponderosa pine stands to prevent outbreaks of mountain pine beetle (Study No.--None. Journal of Forestry).

Sartwell, C. 1970. Ips pini attack intensity in ponderosa pine thinning slash as related to felling date in eastern Oregon. (Study No.--None. U.S. Forest Serv. Res. Note).

Sartwell, C., R. E. Dolph, and L. N. Kline. 1970. Minimizing tree killing by Ips pini in recently thinned ponderosa pine stands (Study No.--None. Station Research Note).

Mason, R. R. 1970. Comparison of flight aggregation in two species of southern Ips DeGeer (Coleoptera: Scolytidae). (Study No.--None. Canadian Entomologist).

Mason, R. R. 1970. Oleoresin exudation flow in relation to soil moisture and stand density in a loblolly pine plantation (Study No.--None. Forest Science).

Problem No. 2--Defoliators.

a. New Studies: None

b. Manuscripts:

Mason, R. R. 1970. Development of sampling methods for the Douglas-fir tussock moth Hemerocampa pseudotsugata (Lepidoptera: Lymantriidae). (Study No.--None. Canadian Entomologist).

Mason, R. R., and J. W. Baxter. 1970. Food preference in a natural population of the Douglas-fir tussock moth. (Study No.--None. Jour. Econ. Ent.).

Mason, R. R., and C. G. Thompson. 1970. Decline of an outbreak population of the Douglas-fir tussock moth. (Study No.--None. PNW Res. Note).

Mason, R. R. 1970. Controlled field test of pyrethrins against the western hemlock looper. (Study No.--None. PNW Res. Note).

Mason, R. R., and T. C. Tigner. Tree-site relationships in an outbreak of the lodgepole needle miner in Central Oregon. (Study No.--None. Ecology).

Tigner, T. C., and R. R. Mason. Host preference of a lodgepole needle miner. (Study No.--None. Ann. Ent. Soc. Amer.).

Wickman, B. E., G. C. Trostle, and P. E. Buffam. 1970. Douglas-fir tussock moth. (Study No.--None. U.S.D.A. Forest Pest Leaflet).

Problem No. 3--Sucking Insects.

a. New Studies: None

b. Manuscripts:

Mitchell, R. G., G. D. Amman, and W. E. Waters. 1970. The balsam woolly aphid. (Study No.--None. U.S.D.A. Forest Pest Leaflet).

Problem No. 4--Regeneration Insects.

a. New Studies: None

b. Manuscripts: None

Problem No. 5--Insect Impact.

a. New Studies: None

b. Manuscripts:

Wert, S. L., and B. E. Wickman. 1970. An aerial photo technique for evaluating tussock moth damage to white fir timber stands. (Study No.--None. Station Research Paper).

Koerber, T. W., and B. E. Wickman. 1970. Use of tree ring measurements to measure impact of insect defoliation. (Study No.--None. In Proc. Conf. on Tree Ring Analysis).

Wickman, B. E. Impact of defoliation by the Douglas-fir tussock moth on white fir. (Study No.--None. Unknown).

Problem No. 6--Forest Products Insects.

a. New Studies: None

b. Manuscripts: None

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-2203 for Year Ending
March 31, 1970

1. Research Work Unit Location: Corvallis, Oregon

2. Research Work Unit Title: Diseases of Western Forest Insects

3. Mission: To improve protection of the forests by determining the role of diseases in regulating insect population densities, by developing means of manipulating diseases to control destructive outbreaks, and by learning the ecological effects of such biological control methods.

4. Summary of Research Work Unit Studies for Each Selected Problem: The work unit was redescribed in 1969 and the previous problem numbers no longer apply. Studies are being redefined and those currently being conducted are tentative pending completion of new problem analyses.

Study-Status Table for Research Work Unit

Problem No.	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1							1	0
2							2	1
3							0	0
Total	3	2				1	3	1

5. Accomplishments for Each Selected Problem:

Problem No. 1--Developing Methods for Predicting and Enhancing the Role of Forest Insect Diseases.

a. Published:

Martignoni, M. E., Iwai, P. J., and Wickerham, L. J. 1969 A candidiasis in larvae of the Douglas-fir tussock moth, Hemerocampa pseudotsugata. J. Invertebrate Pathol. 14: 108-110.

A new strain (designated NRRL Y-7043) of the yeast Candida zeylanoides (Castellani) Langeron et Guerra was isolated from the alimentary tract of one dead larva of a laboratory strain of the Douglas-fir tussock moth, Hemerocampa pseudotsugata. Strains of C. zeylanoides have been isolated from various sources, including vertebrate animals and invertebrates, but apparently in no instance has it been shown to be pathogenic. The colony morphology and the carbon assimilation reactions of the new strain were described. Infectivity tests with strain NRRL Y-7043 and with six other strains indicated that the yeast appears to be a conditioned enteropathogenic microorganism for larvae of H. pseudotsugata, capable of causing a fatal disease at high inoculation doses. Significantly, the yeast cells proliferate abundantly in the hindgut of the larvae, where the milieu is slightly acidic. Certain secondary -- or predisposing etiologic factors -- may contribute to the onset of the candidiasis and influence its course. Yeasts are known to invade the host organism when its general resistance is lowered or altered: it is possible that insects continuously reared in the laboratory on artificial diets may have low resistance to certain enteric pathogens.

Problem No. 2--Using Insect Pathogens as Biological Substitutes for Chemical Insecticides.

a. Published:

Breillatt, J. P., Martignoni, M. E., and Anderson, N. G. 1969. Virus isolation for large-scale insect destruction. Bio-physical Journal 9, Abstracts, 262.

A new rotor was tested for the large-scale purification of nucleopolyhedra. The rotor (K-X) permits isolation of the inclusion bodies from a stream (up to 16 liter per hour) flowing over 6.7 liters of sucrose gradient at rotor velocities up to 35,000 rpm. The particles are banded at their isopycnic zone in the gradient. A commercial preparation of nucleopolyhedra from Heliothis zea was used for this study. The centrifuge runs were conducted at the Oak Ridge National Laboratory, and the analysis of the fractions was performed in Corvallis. The advantage of the K-X rotor over zonal rotors of the B series (see Martignoni et al., J. Invertebrate Pathol. 11, 507, 1968) is that it permits concentration of inclusion bodies from relatively large volumes of homogenates of insect tissues.

Maksymiuk, Bohdan. 1969. Proceedings of the Joint United States-Japan Seminar on Microbial Control of Insect Pests. J. Invertebrate Pathol. 13: 159. (Book review.)

b. Unpublished:

(1) Two tussock moth viruses:

Two different nuclear polyhedrosis viruses of the Douglas-fir tussock moth have been studied and described. In one case, polyhedral bodies contain single virus particles only; in the other case, virus particles occur in bundles in the polyhedra. The same host tissues are affected by the two viruses. The dimensions of the two types of virus rods differ. Most of the samples of viruse examined from different geographic locations have contained only the single-rod virus. A detailed report is in press and study is continuing.

(2) Aberrant virus particles:

What appear to be aberrant forms of the single-rod virus of the Douglas-fir tussock moth have been studied. A report is being prepared.

Problem No. 3--Noninfectious Diseases in Forest Insect Populations: Occurrence, Distribution, and Transmisstion.

This work will not be initiated until staff and facilities are available.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Developing Methods for Predicting and Enhancing the Role of Forest Insect Diseases.

a. New Studies: None

b. Manuscripts:

Hughes, K. M., and Addison, R. B. Two nuclear polyhedrosis viruses of the Douglas-fir tussock moth. J. Invertebrate Pathol.

Hughes, K. M. Possible aberrant forms of an insect virus. J. Invertebrate Pathol. (?)

Mason, Richard R., and Thompson, C. G. Collapse of an outbreak population of the Douglas-fir tussock moth, Hemerocampa pseudotsugata (Lepidoptera: Lymantriidae). Sta. Res. Pap.

Problem No. 2--Using Insect Pathogens as Biological Substitutes for Chemical Insecticides.

a. New Studies: None

b. Manuscripts:

Martignoni, M. E., and Iwai, J. P. A quantitative study of purified nucleopolyhedron fractions. J. Invertebrate Pathol.

Martignoni, M. E., and Iwai, J. P. Serologic procedures for the identification of entomogenous viruses. J. Invertebrate Pathol.

Steinhaus, E. A., and Martignoni, M. E. An abridged glossary of terms used in invertebrate pathology: Second, completely revised and augmented edition. Station publication.

Problem No. 3--Noninfectious Diseases in Forest Insect Populations: Occurrence, Distribution, and Transmission.

a. New Studies: None

b. Manuscripts: None

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-2204 for Year Ending March 31, 1970

1. Research Work Unit Locations: Portland and Corvallis, Oregon

2. Research Work Unit Title: Nutrition, behavior, and population dynamics of western forest insects.

3. Mission: To increase the understanding of population dynamics of important forest insects by studying their physiology, behavior, and factors that affect their abundance; and to utilize these findings for devising or improving control techniques, particularly those of a biological nature.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem Number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	3	0	0	0	0	0	3	0
2	1	0	0	0	0	0	1	0
3	2	0	1	0	1	0	2	0
4	0	1	0	0	0	0	0	1
5	2	0	0	0	0	0	2	0
Total	8	1	1		1		8	1

5. Accomplishments for Each Selected Problem:

Problem No. 1.--To determine the feasibility of controlling the European pine shoot moth by either the sterile-male technique or trapping based on sex attraction, in combination with other methods as needed.

a. Published:

Daterman, G. E. 1969. Easy recognition of mated females of the European pine shoot moth. J. Econ. Entomol., 62(2): 527-528.

An external feature involving body scales is described for distinguishing mated from nonmated females. In most cases this could be accomplished without magnification. Four other moth species, including another member of the same genus, Rhyacionia zozana, were examined and did not have this characteristic.

Daterman, G. E. 1969. Reproductive biology of the European pine shoot moth, Rhyacionia buoliana (Schiffermüller) (Lepidoptera: Olethreutidae), with special reference to mating behavior, sex attraction, and fecundity. Ph.D. Thesis, Oregon State Univ., Corvallis. 105 pp.

Mating behavior of the insect is described with particular reference to the role of the female sex pheromone. A caging technique is described for obtaining fertilization of females in the laboratory. When moths of either sex older than 4.5 days were used for breeding, mating efficiency decreased. Females older than 2.5 days when fertilized deposited fewer eggs than females mated at a younger age. Females are normally limited to one mating, whereas males mated up to six times with an average of 2.24.

Fecundity decreased and was accompanied by higher egg mortalities under constant "dry" air conditions in the laboratory when all other conditions were favorable. Constant temperatures in excess of 92°F caused egg mortality despite the level of air moisture.

Females varied in their attractiveness, with some apparently incapable of attracting any males to sticky traps and others capturing high numbers. The source of pheromone production was a gland on the dorsum of the abdominal tip between the penultimate and terminal segments (8 and 9). The gland is similar in location and gross structure to most other moth pheromone glands described in the literature.

Problem No. 2.--To evaluate the biological threat of the European pine shoot moth to natural pine stands, particularly ponderosa and lodgepole pines.

A test proposal for free release of European pine shoot moth in an isolated pine stand was advanced as a means of clarifying the assumed threat to the Pine Region. The outcome of several meetings with co-operators and interested parties was rejection of the proposal, on the grounds that the test posed too great a hazard of the moth escaping from the test area to the pine forest.

Problem No. 3.--To determine the behavioral and environmental requirements of insect parasites, with the objective of using these insects to control forest defoliators.

a. Published: None

b. Unpublished:

An inundative parasite release was tested as a means for reducing European pine shoot moth pupal populations, prior to use of the sterile-male or attractant control methods against adults. A total of 5,365 female Itoplectis quadricingulatus (Provancher) was released on a 40-acre site over a 7-week period. Although weather at the test site was rather unfavorable for parasite survival, approximately 30% of the shoot moth pupae were killed by I. quadricingulatus. The test demonstrated the feasibility of parasite releases in an integrated control program. Population reduction achieved compared favorably with that expected from a similar number of sterile males, and because of less expensive rearing methods the cost of parasite liberation was considerably less.

Interaction of Apechthis ontario and Itoplectis quadricingulatus.

Equal numbers of female A. ontario and I. quadricingulatus were allowed to compete for daily allotments of hosts placed in a laboratory population cages. Differential parasitization within the cages was obtained by stratifying the within-cage environment by means of light intensity. Parasitization was compared to that in similar cages where each species operated alone. The more rapid maturation of I. quadricingulatus allowed it to predominate at the beginning of the experiment, whereas A. ontario predominated toward the end because of its greater longevity. I. quadricingulatus predominated at the higher light intensities, although survival of

both species, but not the total host mortality, was reduced compared to where the parasites were operating alone. At low light intensities the activity of both species was so reduced that parasitization of neither appeared different from that when each operated alone.

These results emphasize that parasites with differing adaptations to environmental factors provide increased reliability in natural control. The classical biological control approach of introducing a multiplicity of parasite species to control forest pests is justified by all findings to date.

Problem No. 4--To study the population dynamics of destructive forest insects, such as the spruce budworm, to develop and improve control methods, particularly by biological and silvicultural means.

a. Published: None

b. Unpublished: None

Problem No. 5.--To determine the physiological characteristics of important forest insects, specifically the spruce budworm and Douglas-fir beetle, to identify steps in life processes that might be used as a basis for control.

a. Published: None

b. Unpublished:

Nutrition of the Douglas-fir beetle.

To test whether or not attack pattern of this beetle has a nutritional basis, inner bark from a number of trees was bioassayed, using artificial media developed by our laboratory and proved efficient for this purpose. Over 4300 newly hatched larvae were used to bioassay 16 trees, age 50-100 years. Preliminary statistical analysis on bark beetle development in sections of these trees showed no nutritional basis for preference.

Physiological basis of melanism in the spruce budworm.

Parameters of the blue chromoprotein as determined by molecular sieve chromotography were verified by electron microscopy, using a negative staining technique, at a magnification of about 60,000. Preparation of materials and microscopy was done by personnel in FS-PNW-2203.

Lyophilizing the blue chromoprotein was found to permit storage without loss of molecular integrity. Use of an insulated container holding the sample being lyophilized is recommended for preventing too rapid warming of the sample, which can result in molecular breakage.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

The work unit description has now been revised and soon will be submitted for approval. Listing of new studies for next year must await completion of problem analyses.

Problem No. 1--To determine the feasibility of controlling the European pine shoot moth by either the sterile-male technique or trapping based on sex attraction.

a. New studies: Pending

b. Manuscripts:

Carolin, V. M., W. K. Coulter, and G. E. Daterman. Laboratory treatments for obtaining overwintering European pine shoot moth larvae. (In draft).

Coulter, W. K. Adult emergence patterns of the European pine shoot moth in western Washington.

_____ Flight behavior of European pine shoot moth in western Washington.

Daterman, G. E. 1970. An improved technique for mating European pine shoot moth Rhyacionia buoliana (Schiff.)(Lepidoptera: Olethreutidae) in the laboratory. Canad. Entomol. (Scheduled for May issue).

_____ and D. McComb. 1970. Female sex attractant for survey trapping European pine shoot moth. J. Econ. Entomol. (In press).

_____ Effects of temperature and saturation deficit on European pine shoot moth egg production. (In draft).

Problem No. 2--To evaluate the biological threat of the European pine shoot moth to natural pine stands.....

a. New Studies: None

b. Manuscripts: None

Problem No. 3--To determine the behavioral and environmental requirements of insect parasites.

a. New studies:

Evaluation of exotic parasites for control of the larch case-bearer in the Pacific Northwest. (Tentative).

b. Manuscripts:

Ryan, R. B. 1970. Interaction between the parasites, Apechthis ontario and Itoplectis quadricingulatus. I. Survival in singly attacked and super - and multiparasitized wax moth pupae. (Approved by Station Editor)

_____ and R. D. Medley. 1970. Inundative release of Itoplectis quadricingulatus against European pine shoot moth in an isolated infestation. (Accepted by J. Econ. Entomol.)

_____ Laboratory reproduction of the parasites, Apechthis ontario and Itoplectis quadricingulatus. I. Rearing Methods.

_____ Laboratory reproduction of the parasites, Apechthis ontario and Itoplectis quadricingulatus. II. Fecundity under different conditions of host scarcity and abundance.

_____ Laboratory reproduction of the parasites, Apechthis ontario and Itoplectis quadricingulatus. III. Effects of excessive humidity on oviposition.

Problem No. 4--To study the population dynamics of destructive forest insects, such as the spruce budworm, to develop and improve control methods.

a. New studies: None

b. Manuscripts:

Carolin, V. M. 1970. Extended diapause in Coloradia pandora Blake (Lepidoptera: Saturniidae). (Sent to Pan-Pacific Entomol.)

_____ and W. K. Coulter. Trends of western spruce budworm and associated insects in Pacific Northwest forests sprayed with DDT. (Approved by Station Editor)

Carolin, V. M. and F. W. Honing. Western budworm. U.S.D.A. Forest Pest Leaflet. (In draft)

_____ and W. K. Coulter. Sampling western budworm on Douglas-fir in eastern Oregon. (In draft)

Problem No. 5--To determine the physiological characteristics of important forest insects....

a. New studies: Pending

b. Manuscripts:

Schmidt, F. H. and C. L. Young. Larval coloration in Choristoneura spp. I. Bile pigment in hemolymph. (Technical review completed)

_____ Larval coloration in Choristoneura spp. II. Molecular weight estimate of blue chromoprotein by gel filtration.

_____ Physiological differences between populations of Choristoneura spp.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Annual Report for Pacific Northwest Forest and Range Experiment Station

Research Work Unit FS-PNW-2301 (Rev.) for year ending March 31, 1970

1. Research Work Unit Location: Corvallis, Oregon.

2. Research Work Unit Title: Diseases Reducing Forest Production.

3. Mission: To identify and evaluate specific disease causes and damage to timber, range, recreation, and other forest resources, and forest products; and to develop biologically and economically sound methods for reducing such damage.

4. Summary of Research Work Unit Studies for Each Selected Problem;

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	5	0	0	0	0	0	5	0
2	3	0	0	0	0	0	3	0
3	1	0	1	0	0	1	1	0
4	1	0	0	0	0	0	1	0
Total	10		1			1	10	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Dwarf Mistletoe of Native Conifers.

Knutson, Donald M. 1969. Effect of temperature and relative humidity on longevity of stored dwarf mistletoe seeds. Phytopathology 59: 1035.

Storage of seed from ponderosa pine dwarf mistletoe at 1° C and 1, 7, and 9 percent relative humidities gave acceptable germination (97%) after five months. The ability to retain seed viability for prolonged periods greatly increases opportunities for study of infection processes, host-parasite relations and potential chemotherapeutants under controlled conditions.

Knutson, Donald M. 1969. Effect of dwarf mistletoe on xylem tissue of ponderosa pine. Northwest Sci. 44: 64.

Stemwood infected by dwarf mistletoe is characterized by hyperplasia and replacement of xylem rays with parasite tissue. Annual rings are distorted; abnormal development of ray cells and tracheids occur. Specific gravity and moisture content of invaded wood is altered significantly from adjacent normal wood. Thus, dwarf mistletoe infections adversely affect wood quality as well as reduce tree growth.

Shea, Keith R. and Benton Howard. 1968. Dwarf mistletoe control: a program for research and development in the West. Proc. Annual Meeting Western Forest Pest Comm., West. Forestry and Conservat. Assoc., San Francisco 1968: 36-43.

Dwarf mistletoes cause annual mortality and growth loss of over 3.2 billion board feet in western forests. A coordinated research and development program is proposed to improve control practices consistent with forest management objectives. Five major tasks are set forth along with projected staffing required to reduce the impact of these parasites on timber production and other forest values. The program will result in more rapid achievement of research and development goals with improved cost-effectiveness ratios.

Problem No. 2--Diseases of Forest Regeneration.

Shea, Keith R., George M. Harvey, H. H. Bynum and John M. Staley. 1970. A new ponderosa pine needle disease in western Oregon plantations. Northwest Sci. 44: 70.

A new needle disease, first noted in 1967, now is epidemic in 19 western Oregon ponderosa pine plantations. The fungus fruits in June and July during rainy periods; infection of current year needles occurs immediately. Infected new foliage turns reddish-brown by late summer; it overwinters and is cast after spore discharge the following year. Repeated defoliation results in reduced tree vigor and increased mortality. This research lays foundations for detailed investigations of epidemiology and control, and for evaluating the potential significance of this striking disease.

Problem No. 3--Estimating defect in upper-slope conifers.

Reliable means for relating defect in standing trees to external indicators have the immediate effect of improving estimates of sound volume. Over 500 true firs have been dissected in southern Oregon. The data obtained are being used to develop mathematical equations for estimating defect in this increasingly valuable timber resource.

Problem No. 4--Other Disease Problems.

Johnson, Norman E., Keith R. Shea, and Richard L. Johnsey. 1970. Mortality and deterioration of looper-killed hemlock in western Washington. J. Forest. 68: 162-163.

Over 60 percent of western hemlocks with 70 percent or more of the foliage consumed by the hemlock looper died within 3 years. Decay of standing looper-killed trees reduced sound volume by 20 percent in 2 years, whereas trees felled while still green lost only 1 percent volume to decay. The recommendations made for reducing decay losses in infested stands can greatly increase utilization of western hemlock in the Pacific Northwest.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Dwarf Mistletoes of Native Conifers.

a. New Studies:

None.

b. Manuscripts:

Occurrence of dwarf mistletoe in sanitized ponderosa pine in south-central Oregon (Northwest Sci.).

Dwarf mistletoe of western hemlock (U.S.D.A. Forest Pest Leaflet).

Physical properties of ponderosa pine bole wood infected by dwarf mistletoe (Forest Product. Jour.).

Intensification of dwarf mistletoe in thinned ponderosa pine (Station Research Note).

Effect of temperature and relative humidity on longevity of dwarf mistletoe (Arceuthobium campylopodum) seeds. (Forest Sci.)

Problem No. 2-- Diseases of Forest Regeneration.

a. New Studies:

None.

b. Manuscripts:

Elytroderma disease of ponderosa pine (U.S.F.S. Forest Pest Leaflet).

Disease and insect activity in relation to intensive culture of forests (Proc. Int. Union Forestry Res. Organizat.).

Problem No. 3--Estimating Defect in Upper Slope Conifers.

a. New Studies:

None.

b. Manuscripts:

Heart rots of grand fir and associated species in the Blue Mountains (Station Paper).

Fomes pini in white fir (Plant Dis. Reporter).

Problem No. 4--Other Disease Problems.

a. New Studies:

None.

b. Manuscripts:

Poria weirii: Problems and progress in the Pacific Northwest. (In Root Diseases and Soil Borne Pathogens. Univ. Calif. Press. In press).

Poria weirii in the Pacific Northwest. (Station Paper. In press).

A method for sampling yeasts and bacteria in sound wood. (Can. J. Bot.)

The bacteria in sapwood, wetwood, and heartwood of trembling aspen (Phytopathology).

UNITED STATES DEPARTMENT OF AGRICULTURE
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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-2302 (Rev.) for Year Ending March 31, 1970

1. Research Work Unit Location: Corvallis, Oregon.

2. Research Work Unit Title: Biology of root diseases and soil microorganisms.

3. Mission: To develop the basis for biological control of root diseases in forests.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	8	0	4	0	2	0	10	0
Total	8		4		2		10	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Biological Control of Root Diseases in Young Forests.

a. Published:

Li, C. Y., K. C. Lu, E. E. Nelson, W. B. Bollen, and J. M. Trappe. 1969. Effect of phenolic and other compounds on growth of *Poria weirii* in *vitro*. Microbios 3: 305-311, illus.

Many naturally occurring phenolics inhibit growth of *Poria weirii*, the root-rotting fungus that causes extensive mortality of western conifers of all ages. Other phenolics, in contrast, stimulate the fungus. Both kinds of compounds occur in trees that are highly susceptible to *Poria* infection, such as Douglas-fir, as well as in highly resistant species such as red alder. However, the concentration of inhibitors is low in Douglas-fir and high in alder. These data provide clues to the biochemical mechanism of resistance, clues that may rapidly advance the identification of resistant strains or species of hosts for use in silvicultural and tree-breeding approaches to biological control of the disease.

Li, C. Y. 1969. Biological influence of red alder on *Poria weirii* and other root rot pathogens. Diss. Abstr. 30B: 1982.

Tarrant, R. F., K. C. Lu, W. B. Bollen and J. F. Franklin. 1969. Nitrogen enrichment of two forest ecosystems by red alder. USDA Forest Serv., Res. Pap. PNW-76, 8 pp, illus.

Stands containing the nitrogen-fixing tree, red alder, have a nearly three-fold increase in nitrogen circulating through litter fall as compared to pure conifer stands. This increase of nitrogen is associated with markedly increased populations of *Streptomyces* and other soil organisms that inhibit growth of root-rotting fungi, particularly *Poria weirii*. In addition, the alder produces large amounts of *Poria*-inhibiting compounds such as phenolics, which are added to the soil by litter fall and probably by root secretion. Such alteration of soil properties by alder mark it as a highly promising species for use in biological control of *Poria weirii* root rot.

Nelson, Earl E. 1969. *Poria weirii*: is there hope for control? Proc. 16th Western Internat. For. Disease Work Conf. 1968: 59-65.

Poria weirii attacks roots and ultimately kills infected trees of virtually all western conifer species. On the basis of what is presently known about *Poria*, control measures must focus on reducing the amount of infected wood in soil. This can hypothetically be done by use of heavy equipment to remove infected stumps and roots from cutover areas. Fertilization or planting of hardwoods such as red alder might be used to change soil properties to the detriment of the fungus. Planting resistant tree species or strains on sites harboring infection would be silviculturally practicable, but at present only hardwoods are known to be completely resistant. Until more is learned about the pathogen, however, we can only grope for successful control measures.

Trappe, James M. and Robert F. Strand. 1969. Mycorrhizal deficiency in a Douglas-fir region nursery. Forest Sci. 15: 381-389, illus.

Without mycorrhizae, conifer seedlings cannot absorb enough nutrients to grow rapidly or even to sustain life. Lack of mycorrhizae has not been thought a problem in regions with abundant coniferous forests, because the beneficial, mycorrhizal fungi are native there as well. However, nursery practices such as land leveling combined with stringent soil fumigation have proven capable of eliminating mycorrhizal fungi from the soil in a newly developed Douglas-fir region nursery. The initial crop of Douglas-fir seedlings grew excruciatingly slowly, suffered heavy mortality, and failed to produce a usable crop of planting stock in 3 years. Clearly, fumigation and other practices that reduce populations of soil organisms must be used with great caution, if the results are not to be more vexing than the problems for which treatment was originally prescribed.

Zak, B. 1969. Characterization and classification of mycorrhizae of Douglas-fir. I. *Pseudotsuga menziesii* + *Poria terrestris* (blue- and orange-staining strains). Can. J. Bot. 47(12): 1833-1840, illus.

Zak, B. 1970. Tuberculate ectomycorrhiza of Douglas-fir, *Pstudotsuga menziesii* + *Rhizopogon vinicolor*. Northwest Sci. 44: 71.

Fassi, B., A. Fontana, and J. Trappe. 1969. Ectomycorrhizae formed by *Endogone lactiflua* with species of *Pinus* and *Pseudotsuga*. 1969. Mycologia 51: 412-414.

Carpenter, S. and J. M. Trappe. 1970. Endomycorrhizae of *Thuja plicata*. Northwest Sci. 44: 60.

Different mycorrhizal fungi can benefit their host trees in different ways and to different degrees. For example, some protect tree roots from disease better than others. Harnessing particularly beneficial fungi for silvicultural purposes requires first, that they be identified. The distinctive features of the mycorrhiza formed by each identified species must then be determined, so that distribution and ecological requirements can be evaluated. Then, silvicultural techniques can be formulated to utilize the fungus for protection of roots from disease or other specific purposes. Marked progress has been made in the early steps of this research process for Douglas-fir and other western conifers. Through this research, the conceptual framework has been developed for similar progress in other parts of the world.

Trappe, J. M. Mycorrhizae. 1969. McGraw-Hill Yearbook of Sci. & Tech. 1969: 227-228.

Infection of tree roots by mycorrhizal or pathogenic fungi involves a sequence of complex interactions. To become established in a soil, a fungus must both be adapted to the properties of that soil and be able to compete with the myriad other organisms present. The fungus must then penetrate the rhizosphere of a host root, a highly selective barrier teeming with specialized microorganisms and influenced by root secretions. The relatively few fungi that succeed this far must further produce the enzymes needed to penetrate root tissue, and additionally must overcome biochemical defenses raised by invaded host tissue. Mycorrhizal fungi are restricted in the manner in which they can grow in host tissue, and do not harm host cells. Pathogens, in contrast, rapidly overcome host resistance and injure or kill the host cells.

Catalfomo, P. and J. M. Trappe. 1970. Ectomycorrhizal fungi: a phytochemical survey. Northwest Sci. 44: 19-24.

Mycorrhizal fungi protect tree roots from disease, although degree of protection varies from one mycorrhizal fungus to another. An understanding of the protective mechanisms is vital for selecting particular mycorrhizal fungi for use in biologically controlling root diseases. Phytochemical studies of numerous mycorrhizal fungi reveal that all produce ergosterol, a probable cell wall constituent. Since ectomycorrhizal fungi typically form a mantle of fungal tissue around root tips, ergosterol is probably important in erecting a physical barrier to pathogens. Production of compounds likely to be involved in antibiotic activity--amines, indoles, and phenols--differs markedly between species of mycorrhizal fungi. Such differences may account for differing protective capabilities.

Thiers, H. D. and J. M. Trappe. 1969. Studies in the genus *Gastroboletus*. Brittonia 21: 244-254.

Trappe, J. M. 1969. Laminated ascus walls in the Tuberales. 11th Internat. Bot. Congr. Abstr., p. 221.

Trappe, J. M. 1969. Taxonomic studies of the European truffle fungi. Yearbook Amer. Phil. Soc. 1968: 339-340.

Trappe, J. M. 1969. Comments on Szemere's "Die unterirdischen Pilze des Karpatenbeckens." Mycologia 51: 170-174.

Mycorrhizal and other root-affecting fungi occur in fantastic diversity in western North America. Many little-known groups appear to be prominent in biological control of tree root diseases. Numerous new species have recently been discovered and described by Forest Service scientists, and monographs of several genera are in progress. This research is building the vitally-needed capability of identifying hitherto unknown but important fungi.

Trappe, J. M. 1969. Studies on *Cenococcum graniforme*. I. An efficient method for isolation from sclerotia. Can. J. Bot. 47: 1389-1390, illus.

Li, C. Y., K. C. Lu, J. M. Trappe, and W. B. Bollen. 1969. A simple, quantitative method of assaying soil for inhibitory fungi. USDA Forest Serv. Res. Note PNW-108, 3 pp., illus.

Innovative research requires innovative techniques for rapid progress. Often, the most useful new techniques are simple and require no special equipment. Mycologists and microbiologists at the Pacific Northwest Forest and Range Experiment Station have devised novel methods of using standard, inexpensive chemicals and glassware to efficiently isolate particular soil fungi and assay soil for antibiotic-producing organisms. Though developed for research on biological control of tree root diseases, the methods are widely applicable in other kinds of disease research.

Peyronel, B., B. Fassi, A. Fontana, and J. M. Trappe. 1969. Terminology of mycorrhizae. Mycologia 51: 410-411.

Simple and precise terminology is needed in scientific communication. Advances in knowledge have proven that some terms used for many decades in mycorrhiza research are both inaccurate and unwieldy. A Forest Service scientist, collaborating with European colleagues, has proposed a simplified, accurate, basic terminology for mycorrhizae. The revised terms have gained wide acceptance in the scientific community and will greatly facilitate communication.

Bollen, W. B., and K. C. Lu. Douglas-fir bark tannin decomposition in two forest soils. USDA Forest Serv. Res. Pap. PNW-85, 12 pp., illus.

Douglas-fir bark is added to the forest floor in large quantities as sloughing from standing and fallen trees and from logging debris. A by-product of lumber and pulp mills, bark is also used extensively as a soil mulch in gardens. Concern about possible adverse effects of tannins in bark on soil chemical or biological properties has been allayed by recent research. The bark and its tannins were found to produce no harmful effects.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Biological Control of Root Disease in Young Forests.

a. New studies:

Root pathogen regulation by red alder: integration of biochemical and biological factors as a model biological control ecosystem.

Effect of incorporated and broadcast nitrogenous fertilizer on survival of *Poria weirii*.

Resistance of northwestern conifers to *Poria weirii*.

Comparison of root disease incidence (especially *Poria weirii)* in pure conifers vs. alder-conifer mixtures.

Effects of wood chips applied to the soil surface and incorporated in the soil on constituents of the soil microflora and survival of *Poria weirii*.

b. Manuscripts

Endogone incrassata: a zygosporic species with hollow sporocarps. Mycologia.

The mycorrhiza-forming Ascomycetes. Proc. 1st No. Amer. Conf. on Mycorrhizae.

A new *Chroogomphus* with a loculate hymenium, and a revised key to section *Floccigomphus*. Mycologia.

A newly determined species of *Elaphomyces* from Oregon. Madroño.

Inhibition of *Poria weirii* and *Fomes annosus* by linoleic acid. Forest Sci.

Separation of phenolic compounds in a forest soil by thin-layer chromatography. Can. Jour. Soil Sci.

Hypogeous macrofungi and mycorrhizae. Proc. 17th Western Internat. Forest Disease Work Conf.

Phenolic Compounds in roots of red alder and Douglas-fir as related to resistance to infection by *Poria weirii*. Forest Science.

Notes on some hypogeous fungi from Mexico. Mycologia.

Survival of *Poria weirii* on paired plots in alder and conifer stands. Sta. Res. Note.

Colonization of stumps by *Poria weirii*. Sta. Res. Note.

Laminated root rot of Douglas-fir. U.S.F.S. Forest Pest Leaflet.

Effects of nitrogen fertilizer on survival of *Poria weirii* and populations of soil fungi and aerobic actinomycetes. Northwest Sci.

Characterization and identification of Douglas-fir mycorrhizae. Proc. 1st No. Amer. Conf. on Mycorrhizae.

UNITED STATES DEPARTMENT OF AGRICULTURE
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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-3101 for Year Ending
March 31, 1970

1. Research Work Unit Location: Portland, Oregon.

2. Research Work Unit Title: Timber Quality Determination for Western Softwoods.

3. Mission: To determine the quality characteristics and develop grading systems for measuring the quality of western softwoods.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	7	2	0	0	0	0	7	2
2	2	0	0	0	0	0	2	0
Total	9	2					9	2

5. Accomplishments for Each Selected Problem:

Problem No. 1--The Need for Better Grading Systems to Estimate End Product Selling Values of Western Softwoods.

a. Published: None.

b. Unpublished:

New and improved grading systems were developed for three important western softwood species.

1. Inland Douglas-fir
2. Engelmann spruce
3. Sitka spruce

These new grading systems employ a new concept in timber grading that will assist the forest industry and public agencies in estimating quality in timber appraisal work.

In-Service reports describing these improved grading systems were prepared for the Forest Service Log Grade Committee. A research paper describing the new system for Inland Douglas-fir is ready for printing.

Research was continued on the development of improved grades for coast type Douglas-fir, western white pine, western hemlock, and the true firs. Additional quality and lumber yield data were obtained on young growth Douglas-fir and old growth hemlock and work was started on two new yield studies for true fir.

The lumber and veneer recovery data developed from the seven active studies continued to provide the timber industry and the public agencies with information useful in making timber appraisals.

Problem No. 2--The Relationship of Specific Log and Tree Characteristics to Timber Quality.

a. Published:

Arganbright, Donald G. and Wilcox, W. Wayne. April 1969. Comparison of parameters for predicting permeability of white fir. American Wood-Preservers' Association, 5 pp.

Lumber, plywood, and wood preserving industries encounter wood drying and treating problems that are unique to white fir. Many of these problems are related to variation in the movement of water and treating solutions in heartwood and sapwood. This research, conducted in cooperation with the University of California, Forest Products Laboratory, Richmond, California, indicates that unlike most species, specific gravity was not a good predictor of permeability but did explain some of the variation in drying. Treatability of heartwood was found to be consistently higher than sapwood--also a condition unique to white fir.

b. Unpublished:

Research was continued on "wetwood" in white fir in cooperation with the University of California. The spatial distribution of wetwood in trees was investigated in relation to fundamental properties of white fir and to the segregation of lumber for drying. Results indicate that wetwood does not adversely affect the fundamental properties of white fir. One of the major drying sorts, the "sinker" sort, was found to come primarily from the center portion of the first 32 feet in the tree which is also the primary source of wetwood.

The relationship of log characteristics to the drying of lumber was also studied. Lumber grade and volume change during drying and surfacing of white fir lumber from logs with differing surface characteristics was investigated. Results indicate that with each step in the processing a greater proportion of the white fir lumber changed grade; most of this change was lumber degrade. Results also showed a higher incidence of degrade in the upper than in the lower grades of lumber and that less than half of the lumber retained initial grade after final drying and surfacing.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--The Need for Better Grading Systems to Estimate End Product Selling Values of Western Softwoods.

a. New Studies: None.

b. Manuscripts:

A new and easier way to estimate the quality of inland Douglas-fir sawtimber. A PNW Research Paper. (Manuscript editing completed--now being prepared for printing)

Estimate of dry veneer volume losses in Douglas-fir plywood manufacture. A PNW Research Paper. (Manuscript sent to technical reviewers March 26, 1970)

Volume and grade of veneer from Black Hills ponderosa pine. A joint Rocky Mountain and PNW Research Paper. (Now in technical review)

American Woods Leaflet - Sitka spruce. A USDA publication. (Submitted to Washington Office for publication March 1969)

American Woods Leaflet - Red Alder. A USDA publication. (Submitted to Washington Office for publication November 1969)

Lumber recovery from Sitka spruce in southeastern Alaska. Station Research Paper. (First draft of manuscript completed)

Lumber and veneer yield of coast Douglas-fir. A series of Station Papers on 11 regional recovery studies in Washington, Oregon, and California.

Lumber and veneer yield of white fir in southern Oregon. A Station Research Paper.

Lumber yield of white pine. Station Paper.

Lumber and veneer recovery from western hemlock on the Olympic Peninsula of Washington. Station Paper.

Grading system for Sitka spruce. Station Research Paper.

Diagraming true fir logs. A PNW Station Paper supplementing the log diagraming guide for western softwoods. (Manuscript draft completed)

Problem No. 2--The relationship of Specific Log and Tree Characteristics to Timber Quality.

a. New Studies:

The occurrence and cause of shake in western hemlock.

b. Manuscripts:

Wetwood in white fir. Station Paper in cooperation with University of California.

Decay in western white pine sawtimber. Station Paper.

Grade and volume change of white fir lumber from rough green to surface dry. (Initial manuscript draft completed)

An automatic control mechanism for a data recording camera. PNW Technical Research Note. (Manuscript awaiting editing)

Identification of veneer through processing. A Technical Note on a research technique.

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Annual Report for Pacific Northwest Forest Experiment Station
Research Work Unit FS-PNW-3501 for Year Ending
March 31, 1970

1. Research Work Unit Location: Seattle, Washington

2. Research Work Unit Title: Wood Construction Concepts

3. Mission: Effective Use of Wood in Building Construction

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year			March 31, 1970	
	Active	Inactive	Begun	Completed	Terminated	Active	Inactive
1	4	0	2	1	0	5	0
2	5	0	1	1	0	4	1
3	3	0	1	0	0	3	1
4	1	0	1	0	0	2	0
5	1	0	0	0	0	1	0
Total	14	0	5	2	0	15	2

5. Accomplishments for Each Selected Problem:

Problem No. 1--More Effective Use of Wood In Multifamily Dwellings

a. Published:

Grantham, J. B. Field measurement of sound insulation provided by wood-framed apartment walls. Forest Prod. J. 20(4):51-59.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Annual Report for Pacific Northwest Forest Experiment Station
Research Work Unit FS-PNW-3501 for Year Ending
March 31, 1970

1. Research Work Unit Location: Seattle, Washington

2. Research Work Unit Title: Wood Construction Concepts

3. Mission: Effective Use of Wood in Building Construction

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year			March 31, 1970	
	Active	Inactive	Begun	Completed	Terminated	Active	Inactive
1	4	0	2	1	0	5	0
2	5	0	1	1	0	4	1
3	3	0	1	0	0	3	1
4	1	0	1	0	0	2	0
5	1	0	0	0	0	1	0
Total	14	0	5	2	0	15	2

5. Accomplishments for Each Selected Problem:

Problem No. 1--More Effective Use of Wood In Multifamily Dwellings

a. Published:

Grantham, J. B. Field measurement of sound insulation provided by wood-framed apartment walls. Forest Prod. J. 20(4):51-59.

Demonstrates that the sound insulation provided by wood-frame walls in Seattle apartments is close to the potential insulation indicated by laboratory tests--unless there is an obvious oversight in design or workmanship. Aids architects and builders to design party walls more efficiently.

Heebink, T. B. 1969. A method of shielding walls and floors for field measurement of sound insulation. Sound & Vibration, 3(5):18-22.

Describes a portable panel system for shielding walls and floors to comply with ASTM requirements for measuring sound transmission. Saves $50 to $100 per field test.

Yeh, C. T. 1970. Damping in wood structures. Doctoral thesis, University of Washington, Department of Civil Engineering.

Analyzes the damping characteristics of wood floor systems with emphasis on plywood subfloor nailed to wood joists or glued with an elastomeric adhesive. Increased knowledge of damping characteristics will aid in designing acceptable lightweight floor systems with savings in construction costs.

b. Unpublished:

Grantham, J. B. Insulating wood frame floors against noise with cellular concrete and resilient channels (submitted to Journal of Homebuilding--NAHB).

Describes the effectiveness of cellular concrete and resilient channels in providing wood-frame floors with superior noise insulation at moderate cost. Should be of interest to builders of low-rise apartments who provide some 25 percent of all living units each year.

Heebink, T. B. A field comparison of urea formaldehyde foam and mineral wool as sound absorptive materials in wood-frame party walls (submitted to Sound & Vibration).

Provides designers and builders with further alternatives for wood-frame party walls that meet FHA requirements for sound insulation.

Problem No. 2--Design of Wood Structural Elements

a. Published:

None

b. Unpublished:

Hann, R. A., Oviatt, A. E., Markstrom, D. M., and Duff, J. E. The moisture content of laminated beams. Manuscript being edited for publication by Forest Products Laboratory.

Summation of three-year national study will present results which may influence changes in industry design practices.

Problem No. 3--Applicability of Wood-Based Building Systems to Schools, Apartments, and Commercial Buildings

a. Published:

None

b. Unpublished:

A comprehensive report on England's consortium approach to school construction and its applicability to the Pacific Northwest is in preparation. The factors contributing to the success or difficulty of each of 10 systems are included as well as the general benefits of the consortium approach.

A masters thesis "A relocatable modular building system for educational facilities" will provide the basis for a report. The steel-frame, wood panel design offers school districts greater flexibility and freedom than the currently used relocatable classrooms.

Problem No. 4--Regional Investigations of Wood Performance

a. Published:

Heebink, T. B. 1970. Performance of exterior natural wood finishes in the Pacific Northwest. Forest Products J., 20(3):31-34.

b. Unpublished:

None

Problem No. 5--Regional Problems in Wood Utilization

a. Published:

None

b. Unpublished:

None

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--More Effective Use of Wood in Multifamily Dwellings

a. New Studies:

Laboratory measurement of the sound insulation provided by a series of 12 wood-frame walls--to evaluate the effect of several construction variables.

Laboratory measurement of the sound insulation provided by a series of 12 wood-frame floor-ceiling constructions--to complement field findings.

b. Manuscripts:

"Sound insulation of wood-frame floors--as determined by field and laboratory test". A summary of field tests in 10 Seattle apartment buildings reveals that field performance equalled or exceeded the airborne sound insulation predicted by laboratory tests.

A digest of a doctoral thesis on damping in wood structures will be prepared to aid those concerned with limiting vibration in wood floor systems.

Problem No. 2--Design of Wood Structural Elements for Exposed Use

a. New Studies:

Design methods and protective treatments which may improve the performance and appearance of structural wood members exposed to the weather.

Field studies and conferences with designers will be continued and exposure studies at the Olympia site are planned to evaluate new methods.

b. Manuscripts:

An outline is in preparation for an illustrated guide for designers on the general problem of "How to protect exposed wood framing." Problem areas to be considered with suggested solutions to specific conditions will include:

1. End-grain surfaces of structural timbers
2. Holes and other fabrication for connections
3. Capillary spaces at connections and joints and obstructions which delay drainage
4. Exposed horizontal and wash surfaces
5. Ventilation of wood members
6. Treatments and finishes

Problem No. 3--Applicability of Wood-Based Building Systems to Schools, Apartments, and Commercial Buildings

a. New Studies:

Satisfying the changing design requirements in Washington's elementary schools with wood products.

b. Manuscripts:

None

Problem No. 4--Regional Investigations of Wood Performance

a. New Studies:

A wood deck structure has been designed and will be constructed in early summer adjoining the footbridge previously built at the Olympia Exposure Site. Experimental methods to prevent the deterioration of fully exposed horizontal members will be evaluated, including several finishes.

b. Expanded Studies:

Regional study of moisture content of glulam members in use will be expanded in the category of special interior

environments. Probe installations in two additional swimming pool buildings, in a cold storage warehouse, and added installations in a skating rink are expected to furnish additional data necessary to reach conclusions of value to designers.

The study of exterior natural finishes conducted at Olympia Exposure Site in cooperation with the Forest Products Laboratory was expanded in October 1969 to include 27 finishes--each exposed on three western species. Ten of the 12 original finishes were renewed at the same time.

Problem No. 5--Regional Problems in Wood Utilization

Assistance has been extended--with Region 10 and the Institute of Northern Forestry--to the State of Alaska seeking opportunities to use native Alaskan timbers to lower the cost of housing and to employ available native labor more fully.

The project acts as liaison between the Forest Products Laboratory, Institute of Northern Forestry, and Region 10 to extend research on the double diffusion treatment of Alaskan timber species. Plans are developing to collect and ship by rail the hemlock, Sitka spruce, and white spruce poles needed for experimental work.

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Annual Report for Pacific Northwest Forest Experiment Station
Research Work Unit FS-PNW-3701 for Year Ending
March 31, 1970

1. Research Work Unit Location: Seattle, Washington.

2. Research Work Unit Title: Engineering Systems for Utilization of Heavy Timber Stands of the Pacific Coast Including Alaska.

3. Mission: To develop engineering systems needed to economically meet forestry objectives in West Coast young- and old-growth stands.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	16	3	4	2	6	5	12	2
2	16	3	4	2	6	5	12	2
3	0	0	0	0	0	0	0	0
4	6	1	3	1	3	0	7	0
Total[1]	16	3	4	2	6	5[2]	12	2

[1] The total is less than the sum of the numbers shown as several studies are common to more than one problem.

[2] Includes three studies reclassified as miscellaneous engineering--not research.

5. Accomplishments for Each Selected Problem:

Problem No. 1--Excessive Cost of Logging Difficult Access Areas.

a. Published:

(1) Binkley, Virgil W. 1969. Planning single-span skylines. Skyline Logging Symposium Proc., Oreg. State University.

Outlines factors to be considered in selecting areas suitable for skyline logging and gives the steps to be taken from preliminary planning to final location of the skyline road.

(2) Campbell, Charles O. 1969. Mechanics of skyline anchoring. Skyline Logging Symposium Proc., Oreg. State University.

Presents recommended rigging configurations for developing maximum stump-holding capability for various skyline anchoring conditions.

(3) Campbell, Charles O. 1970. Supplement to "Skyline Tension and Deflection Handbook." USDA Forest Serv. Res. Pap. PNW-39 (Supp.), 25 pp., illus.

Presents a graphical solution to facilitate the calculation of the skyline payload capability given in the "Skyline Tension and Deflection Handbook."

(4) Carson, Ward W. 1969. Computer design of single-span skylines. Skyline Logging Symposium Proc., Oreg. State University.

Outlines the mathematical approach to computerized solutions to skyline designs and gives information on the applications to large and small computers.

(5) Lysons, Hilton H. 1969. Grapple yarding revolutionizes yarding. Western Conservation Jour. v. 26, No. 3, 2 pp., illus.

Describes the evolution of grapple yarding and its impact on the logging industry.

(6) Mann, Charles N. 1969. Mechanics of running skylines. Skyline Logging Symposium Proc., Oreg. State University.

Gives a general outline of typical running skyline systems and a procedure for determining their payload capability.

b. Unpublished:

(1) A two-line mechanical slack-pulling carriage has been developed for running skyline systems to extend yarding distance. A patent application is being prepared to cover what may be a valuable invention.

(2) The risks associated with the use of hydrogen as a lifting gas in a logging balloon have been reviewed in the event that someone may elect to take the chance of using a dangerous gas as a means of reducing inflation costs.

(3) Snow loading on logging balloons can be a serious problem in an area such as Southeastern Alaska. Studies show that this loading can be substantially reduced by shrouding the top of a balloon with a pulsating membrane.

(4) A review of current logging and transportation systems criteria points up the need for more specific criteria and a reorientation of planning activities as a means of advancing multiple use management practices.

(5) The magnitude of the loads involved in sideblocking a skyline have been analyzed mathematically. This study pointed up the extreme dangers in this practice unless special provisions are made to relieve the tensions when working limits are exceeded.

(6) A mathematical analysis was made of the load involved in laterally displacing the tail end of a skyline by means of a waistline and a guinea line. Results showed that dangerous overloading can be encountered unless unloading provisions are built into the yarder.

Problem No. 2--Excessive Cost of Harvesting Timber from Esthetically, Ecologically, or Erosively Sensitive Areas.

a. Published:

See publications listed under Problem No. 1 (5a).

b. Unpublished:

See all findings listed under Problem No. 1 (5b).

Problem No. 3--High Extraction and Social Costs Associated with Logging Residues.

a. Published:

No studies specifically oriented to Problem No. 3 have been initiated to date.

b. Unpublished:

(1) Problem analysis shows that it is highly feasible to develop the means of improving logging technology to -

(a) reduce log breakage and resulting residues

(b) reduce residue concentrations and resulting unsightly appearance

(c) reduce the cost of yarding wood residues.

Problem No. 4--Excessive Cost of Logging Partial Cuts Under Adverse Operating Conditions.

a. Published:

See publications numbered 1, 2, 3, 4, and 6 listed under Problem No. 1 (5a).

b. Unpublished:

See findings numbered 1, 4, 5, and 6 listed under Problem No. 1 (5b).

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Excessive Cost of Logging Difficult Access Areas.

a. New Studies:

(1) Logging balloon stability analysis.

(2) Desk-top computer design of standing skylines.

b. Manuscripts:

(1) A technique for the solution of transcendental skyline equations (Study No. 27--Station publication).

(2) Desk-top computer design of running skylines (Study No. 48--Station publication).

(3) Mechanics of sideblocking skylines (Study No. 42--Station publication).

(4) Digitizing terrain data for skyline design programs (Study No. 27--Station publication).

(5) Scribner board foot/cubic foot conversion factors as affected by log length, diameter, and taper (Study No. 25--Station publication).

(6) A computer program for determining the load-carrying capability of running skylines (Study No. 28--Station publication).

(7) Gross static lifting capacity of logging balloons (Study No. 23--Station publication).

Problem No. 2--Excessive Cost of Harvesting Timber from Esthetically, Ecologically, or Erosively Sensitive Areas.

a. New Studies:

See new studies numbered 1 and 2 listed under Problem No. 1 (6a).

b. Manuscripts:

See manuscripts numbered 1 through 7 listed under Problem No. 1 (6b).

Problem No. 3--High Extraction and Social Costs Associated With Logging Residues.

a. New Studies:

Plans to initiate studies specifically oriented to Problem No. 3 subject to available manpower.

b. Manuscripts:

None.

Problem No. 4--Excessive Cost of Logging Partial Cuts Under Adverse Operating Conditions.

a. New Studies:

See new study number 2 listed under Problem No. 1 (6a).

b. Manuscripts:

See manuscripts numbered 1 through 6 listed under Problem No. 1 (6b).

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-4101 for Year Ending
March 31, 1970

1. Research Work Unit Location: Portland, Oregon.

2. Research Work Unit Title: Forest Survey in the Pacific Northwest.

3. Mission: To collect, compile, analyze, and keep current basic information relating to present and prospective timber supplies and demands for timber in the States of Oregon, Washington, California, and Hawaii.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	6	0	2	0	0	0	7	1
2	4	0	1	0	0	0	5	0
Total	10	0	3	0	0	0	12	1

5. Accomplishments for Each Selected Problem:

Problem No. 1--Inventory of Forest Land Area and Timber Resources

a. Published:

Bolsinger, Charles L. 1969. The timber resources of the Olympic Peninsula, Washington. Resource Bulletin PNW-31, 68 pp., illus.

The five counties of the Olympic Peninsula contain nearly one-third of the total commercial forest land and timber volume in western Washington. Over the past 30 years the stocking and general condition of forest land in this area, particularly that in private ownership, has greatly improved primarily as a result of more effective fire protection and to reforestation efforts. Whereas in the late 1930's nearly 350,000 acres of forest land were classed as nonstocked as a result of past fires and cutting practices, in 1965 less than 50,000 acres were classified as nonstocked. The Peninsula now contains a large acreage of young-growth timber just reaching merchantable size which are beginning to be harvested. Currently growth and cut for the Peninsula as a whole ran about equal, a vastly different situation from 1938 when cut exceeded

growth by over 800 percent and yet was only 40 percent greater than the current harvest. Competition for the use of forest land is increasing rapidly as the result of population and prosperity in western Washington. It is anticipated that over 200,000 acres of productive forest land will be converted to urban-suburban industrial or recreational use by the year 2000. Over 400,000 acres of former conifer sites have been occupied by hardwood stands following cutting. These areas are producing less wood fiber than if they had been restocked by conifers.

Wall, Brian R. Projected developments of the timber economy of the Columbia-North Pacific region. Research Paper PNW-84, 1969.

This study reexamines the current timber resource and forest economy and projects future wood consumption, forest employment and forest based payrolls to the year 2020. Total wood consumption is expected to decline 11 percent by 2020. This decline is expected to take place primarily in those areas which have traditionally been the major centers of forest industry--western Oregon, western Washington, western Montana, and northern Idaho--due to decreasing production from private lands. Wood consumption is expected to increase in other portions of the Columbia-North Pacific Region due primarily to expected increases in production from public lands.

Over the entire Columbia-North Pacific Region total employment in the forest industry in 2020 is expected to be about two-thirds of the 1965 level. Modest increases in employment in the pulp and paper industry and forest management will be more than offset by declining employment in the lumber and wood products industry. Despite a decrease in total employment, increasing productivity is expected to result in a two-fold increase in payrolls by 2020.

Wong, Wesley H. C. Jr., Wick, Herbert L., and Nelson, R. E. 1969. Plantation timber on the island of Maui 1967. Resource Bulletin PSW-11, 42 pp., illus.

The island of Maui contains 6,000 acres of commercial plantations of exotic species, primarily eucalyptus. These plantations currently contain 94 million board feet of sawtimber (18 million cubic feet of growing stock). Eighty-five percent of the volume and 54 percent of the area of these stands are in private ownership; the rest is State-owned. These stands are the basis for timber products to meet current and future needs.

b. Unpublished:

None.

Problem No. 2--Forest Products Output, Timber Cut, and Timber Utilization.

a. Published:

Wall, B. R. 1968 Oregon timber harvest. Resource Bulletin PNW-29, 2 pp., illus.

Wall, B. R. 1968 Washington timber harvest. Resource Bulletin PNW-30, 2 pp., illus.

Log production in 1968 was the second highest on record for both Washington and Oregon--a total of 16.7 billion board feet. Production was nearly 17 percent higher than 1967 in both States. In both States production from public lands rose 19 percent over 1967 while production from private lands rose approximately 15 percent.

b. Unpublished:

None.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Inventory of Forest Land Area and Timber Resources.

a. New studies:

None.

b. Manuscripts:

Timber resources of the Puget Sound area, Washington (Resource Bulletin)

Timber resources of Mendocino and Sonoma Counties, California (Resource Bulletin)

Timber resources of central Washington (Resource Bulletin)

Timber resources of eastern Washington (Resource Bulletin)

Timber flows and log utilization patterns in the Douglas-fir region, 1966

Problem No. 2--Forest Products Output, Timber Cut, and Timber Utilization.

a. New studies:

Amount and kind of residues left after clearcut logging on the National Forests of Washington, 1968.

b. Manuscripts:

Forest products output and timber cut in Washington, 1968. (Cooperative report with State of Washington).

Forest products output and timber cut in California, 1968. (Cooperative report with State of California).

Forest products output and timber cut in Oregon, 1968. (Cooperative report with State of Oregon).

History of log production in Oregon and Washington, 1925-1968. (Resource Bulletin)

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-4102 for Year Ending
March 31, 1970

1. Research Work Unit Location: Portland, Oregon.

2. Research Work Unit Title: Survey Techniques--PNW.

3. Mission: To develop more efficient methods of conducting forest inventories and making resource analyses.

4. Summary of Research Work Unit Studies:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
Total	2	1	3	0	1	0	4	1

5. Accomplishments:

a. Published:

None.

b. Unpublished:

Study: Efficiency of Photo Volume Stratification

Analysis of data from 12 counties in Washington confirms that the current Forest Survey design, a stratified double sample with proportional allocation of field plots, is an efficient method for estimating inventory volume. By using aerial photos to stratify the field sample, volume estimates are obtained at less than half the cost of a straight field plot survey of equal precision. For individual counties, cost reduction varied from 38 to 68 percent. An additional 4 percent could have been saved by optimum allocation of the field plots. However, experience has shown that an allocation which is optimum for one objective is likely to be inefficient for many of the other objectives Forest Survey has.

Study: Establishing Realistic Standards for Forest Stocking and Productivity.

Estimates of the capacity of a given piece of land to support tree stocking and produce timber are commonly based on the normal yield table values for the site index of the area. However, it has become apparent in recent years that site index alone is not always an adequate measure of productive capacity. Many acres simply are not capable of supporting the normal yield table level of stocking for the measured site index. Reductions in stocking capacity can apparently be caused by differences in microsite, inclusions of small nonforest areas such as rock outcrops and streambeds, and shallow soils or moisture limitations. As a result, this procedure can lead to underestimation of stocking and overestimation of productive capacity.

Analysis of several hundred Forest Survey field plots in the Blue Mountain area of eastern Oregon reveals that conditions which limit stocking capacity are widespread in this area, primarily in the ponderosa pine type. Productivity estimates based on normal yield tables were compared with more realistic estimates available from an ecological study of the area. Nearly 60 percent of the commercial forest plots were found to have productive capacities below those indicated by the site index and normal yield table. It is evident that in this area of eastern Oregon normal yield table values based on site index measurements are not a suitable standard for estimating either stocking level or productive capacity.

Study: Bias in Photo Plot Sampling Caused by Nonuniform Photo Distribution.

A study of six A.S.C.S. aerial photo projects in western Oregon and Washington shows that the photos are not uniformly distributed over the land surface. In each project the photo intensity, or number of photos per unit of land surface, was greater over nonforest than it was over forest land. The average difference in photo intensity was 4.1 percent, large enough to cause a serious bias in all estimates from a forest inventory using photo plots chosen randomly or systematically on the photos.

6. Research Work Unit Plans for Next Year

a. New studies:

None.

b. Manuscripts:

Bias in photo plot sampling due to nonuniform spacing of aerial photos (Photogrammetric Engineering).

Convex programing for sampling on successive occasions with multiple objectives (Forest Science).

Sampling theory for area estimation with partial replacement (Technical Journal).

Monte Carlo trials of the efficiency of partial replacement estimators (Technical Journal).

Efficiency of volume stratification by aerial photos in the Forest Survey of the Pacific Northwest (Technical Journal).

UNITED STATES DEPARTMENT OF AGRICULTURE
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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-4201 for Year Ending
March 31, 1970

1. Research Work Unit Location: Portland, Oregon.

2. Research Work Unit Title: Production Economics.

3. Mission: To provide sound and effective economic guides for the allocation of forest land, manpower, capital, and management effort to timber production in the major timber types of the Pacific Northwest and Alaska; to consider the multiple-use and macro-economic consequences of timber management decisions

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	0	0	2	0	0	0	2	0
2	4	2	1	0	1	2	4	0
Total	4	2	3	0	1	2	6	0

5. Accomplishments for Each Selected Problem:

Problem No. 1--Systems Analysis of Timber Management Decisionmaking Processes

a. Published:

None.

b. Unpublished:

Analysis of a 500,000-acre management unit in the Douglas-fir region of western Oregon and Washington has revealed that shifting from Scribner log rule to cubic-foot measure does not eliminate allowable cut falldown at the end of the old-growth

conversion period. Effects of shortening rotation and intensified timber management on size of falldown can be significant.

Linear programing is being investigated as to a possible means to schedule old-growth cutting operations during the conversion period. Preliminary findings show that unless input data can be segregated on the basis of site productivity, linear programing has no advantage over the traditional area-volume check scheduling procedure.

Problem No. 2--Economic Feasibility of Intensified Forestry Practices.

a. Published:

Chappelle, Daniel E. A computer program for evaluating forestry opportunities under three investment criteria. PNW Res. Pap. 78, 64 pp., illus.

Describes a computer program written in FORTRAN IV for evaluating investments by use of criteria of present net worth, benefit cost ratio, or internal rate of return.

Schallau, Con, Maki, Wilbur, and Beuter, John. Economic impact projections for alternative levels of timber production in the Douglas-fir region. The Annals of Regional Science, Vol. 3, No. 1, pp. 96-105, illus., 1969.

For most of the region total employment and population is forecasted to increase by 1980 with or without a 20 percent increase in log production. Some areas, particularly southwestern Oregon, may experience depopulation unless nontimber-producing employment increases substantially. Forecasts show that although the timber industry stimulates economic development of the Douglas-fir region, growth of its economic subareas cannot be assured by a sustained level of cut from its forests.

Yoho, James G., Chappelle, Daniel E., and Schweitzer, Dennis L. Economics of converting red alder to Douglas-fir. Res. Paper PNW-88, 31 pp.

This study defines those conditions where it is more profitable to replace red alder stands with Douglas-fir than to manage red alder. Under most of the circumstances analyzed, red alder stands should be immediately converted. In order of importance, the critical variables in this decision were found to be the discount rate,

site productivity, expected stumpage prices, the present age of the existing red alder stand, cost conversion, and annual management cost. Sensitivity analyses suggest how these variables influence the conversion decision.

b. Unpublished.

Results of two economic feasibility studies of accelerated access road construction--one of an old-growth management situation, the other young growth--demonstrate quite convincingly that advance roading is not economically feasible for the two case study areas.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Absence of Economic Guides and Scheduling Techniques for Timber Management Activities.

a. New Studies:

Modification of the Bureau of Land Management's allowable cut simulation model.

b. Manuscripts:

Allowable cut falldown as affected by log rules, rotations, and intensified management (Journal of Forestry article).

An economic analysis of accelerating road construction on the Bureau of Land Management's Tillamook project (Station Paper).

An economic analysis of alternative rates of investment in National Forest road construction: the North Umpqua case (Station Paper).

The economics of forest fertilization in the Douglas-fir region of the Pacific Northwest--a case study (Research Note).

Problem No. 2--The Inability to Relate Timber Management Decisions to Production of Nontimber Goods and Services from Forest Land.

a. New Studies:

A problem analysis will be prepared.

b. Manuscripts:

None.

Problem No. 3--Lack of Information About the Impact of Forest Management Decisions on Local and Regional Economies.

a. New Studies:

A problem analysis will be prepared.

b. Manuscripts:

None.

UNITED STATES DEPARTMENT OF AGRICULTURE
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Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-4301 for Year Ending
March 31, 1970

1. Research Work Unit Location: Portland, Oregon.

2. Research Work Unit Title: Marketing Economics (Marketing--PNW).

3. Mission: To provide guides for expanding markets and improving marketing systems and methods of timber appraisal and sale.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	1	0	1	0	0	0	2	0
2	4	0	1	0	2	0	3	0
3	1	0	0	0	0	0	1	0
4	2	0	0	0	1	0	1	0
5	2	0	0	0	0	0	2	0
Total	10		2		3		9	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Intermediate Cuts and Small, Low Grade Materials Not Being Fully Utilized

a. Published:

None.

b. Unpublished:

Emphasis in this project has shifted to include development of sales arrangements for logging residues in addition to work being done on thinning and other intermediate cut sales. A detailed problem analysis is underway.

The R-6 National Forests have begun a large scale program to require 100-percent yarding of unutilized material, together with pricing of substandard logs on a lump sum per-acre basis. This is administered as a smoke management program, to facilitate slash burning of piled slash under more favorable burning conditions than possible with broadcast burning, and to encourage utilization by absorbing the yarding cost of this material as well as offering it on a near zero direct-cost basis.

Problems of this clean logging policy include payment of road maintenance charges, scaling to determine log grade among payment classes, and disposition of low-value No. 3 logs which on a scale sale must be paid for at full-bid species rates.

Preliminary findings indicate that part of the problem involves changes in pulpmill and sawmill wood procurement methods and development of specialized logging equipment and skills, so as to provide an efficient utilization outlet for this material. Industry will need some time to adjust fully to the new clean logging policy.

Problem No. 2--Need for Information on Alternative Procedures for Appraising and Selling Public Timber

a. Published:

Hamilton, Thomas E. 1970. Stumpage price responses to changes in the volume of timber sold. Res. Pap. PNW-92.

A study of National Forest stumpage prices showed a longrun increasing trend since 1950. This trend is expected to continue throughout the 1970's, but begin to level off after that time.

Although these prices have trended upward, a good deal of fluctuation has occurred on a year-to-year basis. These fluctuations were found to be closely related to shifts in general economic activity--such as level of housing starts, gross national product, the unemployment rate, and the index of common stock prices--and the resultant changes in demand for wood products. In addition, rapid expansion of log exports appeared to exert an upward pressure on stumpage prices. On the other hand, variations in National Forest timber sale volume did not prove to be good indicators of stumpage price changes.

The study showed that adoption of new local and regional timber management programs should not induce short-term stumpage price changes and that the benefits from new programs can be calculated using anticipated long-term price trends.

Benefits: This study should provide public timber selling agencies with a more complete picture of returns which can be expected from timber sales. In addition, it will provide insights into the stumpage price consequences of altering timber sale policies and can be used as a guide in choosing between alternative programs. Finally, it will be useful in forecasting future wood products supply-demand relationships.

Austin, John W. 1970. Timber flows and utilization patterns in the Douglas-fir region, 1966. Res. Pap.

An analysis of log flows showed that intra-area log movements are limited in the Douglas-fir region (west of the Cascade Range in Washington, Oregon, and California); most of the region's logs are used in the area where harvested. The region was divided into 15 areas based on economic criteria, and in nine of these over 70 percent of the logs used came from within the area's boundaries. This means that (1) timber management practices designed to stimulate a community's economy must be instituted locally, and (2) competition for timber sales comes primarily from firms located in the same general geographic area.

Private lands contributed 55 percent of the total regional log supply; followed in order of importance by lands owned and managed by the Forest Service, the Bureau of Land Management, the three States, and the Bureau of Indian Affairs.

The lumber industry was the most important log consumer, using 58 percent of the total supply. Most of the remaining volume was taken by the plywood and pulp industries which used 30 and 11 percent, respectively.

Benefits: This study should provide public timber land managers and policy makers with insights into the geographic implications of timber policy decisions. It helps explain differences in timber values in different areas by relating log flows and available end use alternatives. In addition, it is a necessary first step for any examination of relationships between forest landowner groups, the forest industries, and the regional economy.

b. Unpublished:

None.

Problem No. 3--Increased Competition for Traditional Sources of Pulpwood.

a. Published:

None.

b. Unpublished:

An examination of available information on the pulpwood market in west coast states indicates that very little data is available on pulpwood prices, methods and costs of transportation, sales arrangements, minimum quality specifications, trends in kinds of material used, and the outlook for the pulpwood using industry. The demand for pulpwood raw material is projected to increase rapidly and pressures for better utilization of wood fiber are becoming more intense.

There are currently 47 pulp plants, 22 particleboard plants, 11 hardboard plants, and 3 insulation board plants in Washington, Oregon, and California. During the period 1959-68, chips and other mill residue use increased from 48.4 percent of total pulpwood consumption in Washington and Oregon to 70.2 percent and total chip and other residue consumption rose over 2½ times, from 2.9 million cords to 7.6 million cords.

Export demand for the region's wood chips is also growing. In 1965, the first year chips were exported to Japan, 76,000 cords were shipped; in 1969, 1.4 million cords were exported and these exports accounted for 12-13 percent of Japan's total pulpwood consumption. By 1975, Japanese chip demand is projected to rise by 62 percent.

Problem No. 4--Increased Foreign Competition in Wood Products Markets, Particularly as it Affects the Pacific Northwest.

a. Published:

Austin, John W. 1969. Log export restrictions of the western States and British Columbia, Res. Pap. PNW-91.

This paper describes restrictions on the export of logs from the western United States, including Alaska and British Columbia. The main provisions of each limitation are presented including description of restricted material, forest landownerships included, and time period covered by the restriction.

Benefits: This study provides information on an important facet of the total log export picture at a time when log exports are of key concern to the entire western region. The report presents heretofore segmented information in a way that will allow easy comparison of restrictions between areas and/or between ownerships by both public and private decisionmakers.

b. Unpublished:

Wood products exports from the U.S. west coast have been growing rapidly in recent years. In 1968, over 13 million tons of wood products, including paper, were shipped from California, Oregon, Washington, and Alaska as compared with a total of 2.5 million tons from the four States in 1962. The value of these exports was $500 million in 1968, also up sharply from the $168 million level of 1962.

The 1968 value and volume of wood-based exports for the four States was as follows:

State	Value (million dollars)	Volume (million tons)
California	67.9	1.4
Oregon	194.8	5.7
Washington	192.0	5.9
Alaska	45.0	.8

In terms of value, about 70 percent of the four States' 1968 exports went to southeast Asian countries; Japan was the largest single importer, receiving 62 percent of total shipments. Seventeen percent of all export value went to Europe; the largest single importer in this area was Italy which accounted for 5 percent of the total.

The port of Longview, Washington accounted for the largest value of wood products reported in 1968, $67 million or 13.4 percent of the total. The largest tonnage went through Newport, Oregon; its export volume of 2.4 million tons accounted for 17.4 percent of total shipments.

Problem No. 5--Need for Improved Economic Information on Forest Products Markets in the West.

a. Published:

Austin, John W. 1969-70. Production, Prices, Employment, and Trade in Northwest Forest Industries, quarterly, 1969. Misc. Pub.

These quarterly marketing reports present current timber industry information. Significant 1969 findings were: softwood lumber production in the western States down 5.8 percent to 20.1 billion board feet; U.S. softwood plywood production down 2.9 percent to 14.3 billion square feet, softwood lumber and plywood prices fluctuated sharply in 1969, with 1969 averages above 1968's; average forest industry employment in Washington and Oregon was 144,800

persons, 2,300 below the 1968 average; Montana and Idaho forest industry employment averaged 21,700 persons; Alaska forest industry employment averaged 2,400 persons; California forest industry employment averaged 87,700 persons for the first 9 months of 1969; softwood log exports from Washington and Oregon were 1.9 billion board feet, Scribner scale, down 5.2 percent; the value of log exports rose from $102.52 per thousand board feet to $117.44 in 1969; northern California softwood log exports were 207 million board feet, down 2.6 percent from 1968 shipments; Alaska's log exports were down 32.3 percent to 31.9 million board feet; British Columbia log shipments at 96.5 million board feet were down 32.1 percent; chip exports from Washington, Oregon, and California increased 27.7 percent to 1.4 million cords; lumber exports from Washington and Oregon totaled 351.7 million board feet, down 6.8 percent; Washington and Oregon plywood exports totaled 133.3 million square feet; public timber sale volume in Washington and Oregon was down 2.2 percent to 7.3 billion board feet; Montana and Idaho public timber sale volume was up 25.6 percent to 2.8 billion board feet; public timber sale volume in California declined 15.9 percent to 1.9 billion board feet; Alaska public timber sale volume was down 44.6 percent to 465 million board feet; and average stumpage prices for these sales were up in all areas as compared to 1968, except on western Oregon State lands, eastern Oregon Indian lands, Forest Service and Indian lands in Montana and BLM lands in Alaska.

Benefits: This publication has an average quarterly circulation of over 1,000 and is used by persons in all phases of the timber industry in the Pacific Northwest. It brings together data from about 30 sources. The benefits are valued at about $1,000 per user equivalent[1/] per quarter. If 10 user-equivalents per quarter can be claimed, net annual benefits are $40,000.

6. Research Work Units Plans for Next Year for All Selected Problems.

Problem No. 1--Intermediate Cuts and Small, Low Grade Materials Not Being Fully Utilized.

a. New studies:

Prepare a problem analysis for the logging residue portion of this problem. Develop new studies in cooperation with R-6 National Forest System, prepare study plans, and begin work on approved studies.

1/ A user-equivalent is based on the use of the entire contents of the publication. It can be based on one person using the entire publication or many persons, each using part of the publication, for whom the total use is equivalent to one person using the entire publication.

b. Manuscripts:

Sales arrangements for clean logging. (in-Service report).

Problem No. 2--Need for Information on Alternative Procedures for Appraising and Selling Public Timber.

a. New studies:

An evaluation of alternative base values for use in National Forest stumpage appraisals in Alaska. This study will provide information on the availability of product values at various points in the marketing process and their suitability for appraising public timber. Analysis of both sawlog and pulp log values will be made.

b. Manuscripts:

The effects of end-product price variation on Douglas-fir stumpage prices, 1950-1966 (Research Paper).

Problem No. 3--Increased Competition for Traditional Sources of Pulpwood.

a. New studies:

None.

b. Manuscripts:

Pulpwood use in Washington, Oregon, and California--limitations and potential (Research Note).

Pulpwood transportation in Washington, Oregon and California (Research Note).

Pulpwood prices in Washington, Oregon, and California (Research Note).

Contractual arrangements between pulpwood buyers and sellers in the Pacific Northwest (Research Note).

Problem No. 4--Increased Foreign Competition in Wood Products Markets, Particularly as it Affects the Pacific Northwest.

a. New studies:

None.

b. Manuscripts:

Waterborne forest products exports from Pacific Northwest and Alaska ports (Research Paper).

Problem No. 5--Need for Improved Economic Information on Forest Products Markets in the West.

a. New studies:

None.

b. Manuscripts:

Production, prices, employment, and trade in Northwest forest industries, quarterly (Misc. Pub.).

Log prices in western Washington and northwest Oregon, 1963-1968 (Research Note).

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1210 for Year Ending
March 31, 1970

1. Research Work Unit Location: Juneau, Alaska.

2. Research Work Unit Title: Culture of Coastal Forests in Alaska.

3. Mission: To develop silvicultural practices that will yield the maximum return from the coastal forest resource within the objectives of multiple use management.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	1	0	1	0	0	0	2	0
2	6	0	0	0	0	0	6	0
3	0	0	1	0	0	0	1	0
4	2	0	0	0	0	0	2	0
Total	9	0	2	0	0	0	11	0

5. Accomplishments for Each Selected Problem:

Problem No. 1--Regeneration on Commercial Sites in Coastal Alaska.

a. Published:

Harris, A. S. 1969. Ripening and dispersal of a bumper western hemlock-Sitka spruce seed crop in southeast Alaska. U.S.D.A. Forest Serv. Res. Note PNW-105, 11 pp., illus.

Investigation during a heavy seed year showed that a mature western hemlock-Sitka spruce stand in southeast Alaska produced 131 pounds of seed per acre. Seed was dispersed over a 1-year period with cone scales opening and closing in response to moisture and seedfall increased by wind. Information on cone condition, seed ripening, and weather conditions associated with seed dispersal is given.

b. Unpublished:

Results of limited trials with Douglas-fir in southeast Alaska were summarized and conclusions drawn. The results of these trials suggest that although Douglas-fir is not native to Alaska, climate alone is not a direct barrier to its northward expansion. The excellent growth recorded further suggests that the species may be of future silvicultural value in southeast Alaska.

A small seed extractor was developed to fill a need for such a machine in connection with processing test seed lots of small-seeded conifer species, and a prototype was built at low cost. An extractor of this type may prove useful at many facilities where conifer seed is processed in small lots.

Problem No. 2--Growth and Yield of Western Hemlock and Sitka Spruce in Coastal Alaska.

a. Published: None.

b. Unpublished:

Analysis was made of growth and regeneration response to partial cutting in a 96-year-old western hemlock-Sitka spruce stand. Results over an 18-year period indicate that partial cuttings may have application in managing young-growth stands in southeast Alaska where aesthetic, recreational, or other values outweigh values derived from clearcutting. However, partial cutting solely as a means to increase quality wood growth on selected crop trees, or to insure regeneration, does not appear justified. Thinning the stand stimulated epicormic branching of Sitka spruce, thus reducing future tree quality. Thinned plots became well stocked with regeneration, mostly western hemlock.

Problem No. 3--Availability of Soil Nutrients Following Timber Harvest and Their Effect on Site Productivity.

a. Published: None.

b. Unpublished:

An exploratory study of soil and foliar nutrient status of forest-grown western hemlock and Sitka spruce was begun. Sampling was done in seedling-sapling-sized stands which became established by natural regeneration after clearcutting. Basic information included elemental soil nutrient levels associated with site and growth rates, measures of inherent tree-to-tree variations in foliar nutrient concentration, and nutrient level variations associated with time of sampling. This information will guide future studies of tree nutrition following timber harvest in southeast Alaska.

Problem No. 4--The Effects of Logging and Silvicultural Practices on the Forest Environment.

a. Published:

(In cooperation with WU PNW 1604): Meehan, W. R., Farr, W. A., Bishop, D. M., and Patric, J. H. 1969. Some effects of clearcutting on salmon habitat of two southeast Alaska streams. U.S.D.A. Forest Serv. Res. Pap. PNW-82, 45 pp., illus.

The effects of clearcutting on streamflow, suspended sediment, stream temperature, log-debris jams, and indirectly on salmon populations of two watersheds were evaluated and compared with an uncut watershed in southeast Alaska. Although some effects were observed, the timber harvest as practiced on these watersheds did not appear harmful to salmon habitat or populations.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Regeneration on Commercial Sites in Coastal Alaska.

a. New Studies: None.

b. Manuscripts:

(1) Harris, A. S. Experience with Douglas-fir in Alaska. (Journal article.)

(2) Harris, A. S. A compact laboratory seed extractor. (Tree Planters Notes.)

Problem No. 2--Growth and Yield of Western Hemlock and Sitka Spruce in Coastal Alaska.

a. New Studies:

(1) Volume formulae and tables for coastal Alaska western redcedar and Alaska-cedar.

b. Manuscripts:

(1) Farr, Wilbur A. and Harris, A. S. Effects of partial cutting on growth, epicormic branching, and regeneration in a 96-year-old stand of western hemlock and Sitka spruce in southeast Alaska. (Study No. 7-1.1, 5, 2.3 - Research Paper.)

(2) Dippold, Ronald M. and Farr, Wilbur A. Volume tables and equations for white spruce, balsam poplar, and white birch of the Kuskokwim River valley, Alaska. (Research Note.)

Problem No. 3--Availability of Soil Nutrients Following Timber Harvest and Their Effect on Site Productivity.

a. New Studies: None.

b. Manuscripts: None.

Problem No. 4--The Effects of Logging and Silvicultural Practices on the Forest Environment.

a. New Studies:

Factors affecting windthrow in southeast Alaska.

b. Manuscripts: None.

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

Annual Report of Pacific Northwest Forest and Range Experiment Station Research Work Unit FS-PNW-1211 for Year Ending March 31, 1970

1. Research Work Unit Location: College, Alaska

2. Research Work Unit Title: Ecology and Growth Requirements of Subarctic Trees and Forests.

3. Mission: To provide ecological and growth requirement information for managing Alaska's boreal forest to obtain optimum resource values.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year					
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	0	0	5	0	0	0	5	
2	3	0	0	0	1	0	2	
3	0	0	0	0	0	0	0	
Total	3		5		1		7	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Regeneration requirements for white spruce and associated species.

a. Published:

Zasada, John C., and Gregory, Robert A. 1969. Regeneration of white spruce (Picea glauca (Moench) Voss) with reference to interior Alaska: a literature review. U.S.D.A. Forest Serv. Res. Pap. PNW-79, 37 pp. Pacific Northwest Forest & Range Exp. Sta., Portland, Oregon.

This paper reviews literature concerning natural regeneration of white spruce in the southern boreal forest and incorporates what is known about this subject for the boreal forests of

interior Alaska. A mineral soil seedbed; reduction of competing vegetation; shade, especially during the first growing season; and an adequate seed supply are the four main regeneration requirements. Absence of a mineral soil seedbed appears to be the critical factor in the southern spruce forests.

b. Unpublished: None

Problem No. 2--Site productivity after alteration by fire and other causes.

a. Published:

Viereck, Leslie A. Soil temperatures in river bottom stands in interior Alaska, pg. 223-233 in Ecology of the subarctic regions, Proceedings of the Helsinki Symposium (Ecology and Conservation no. 1) UNESCO. Paris. 364 p.

Soil temperatures were recorded in the following four stages of forest succession along the Chena River near Fairbanks, Alaska: (1) a willow stand on a newly exposed gravel bar, (2) a 50-year-old balsam poplar stand, (3) a 120-year-old white spruce stand, and (4) a 220-year-old white spruce/black spruce stand. In the early successional stands of willow and balsam poplar, the soil froze quicker and deeper, and reached lower temperatures than in the later successional stages. In the willow stand, thawing was completed by the end of May; whereas in the white spruce/black spruce stand, thawing did not begin until the end of May and was never completed--a continuous frozen layer being present at a depth of 40 to 80 cm. The insulating effects of a thick moss layer accumulation under spruce, and deposits of fine river alluvium during flood stages, account for delayed thawing and colder soil temperatures in the spruce stands as compared with the willow and balsam poplar stands.

Viereck, Leslie A. 1970. Forest succession and soil development adjacent to the Chena River in interior Alaska. Arctic and Alpine Research 2: 1-26.

Four stands on varying-aged river deposits were compared with a climax stand on a higher and older terrace to show changes in soil and vegetation with time. Forest succession proceeds from the near xeric conditions of a gravel bar to mesic balsam poplar and white spruce stands. A permafrost layer develops,primarily as a result of the development of a thick organic layer and the interaction with the subarctic climate. Succession continues from the mesic condition of the white spruce to the hydric condition of a slow-growing black spruce stand with a thick saturated sphagnum mat on a permafrost table only 20 to 30 cm. below the moss surface.

Problem No. 3--Growth patterns for white spruce and related species.

a. Published:

VanCleve, K. and Zasada, J. 1970. Snow breakage in black and white spruce stands in interior Alaska. Journal of Forestry 68(2): 82-83.

Quantitative evidence now indicates the importance of snow and ice breakage to the development of white and black spruce stands in interior Alaska. During the winter of 1967-68, 28 percent of the stems in a 160-year-old black spruce and 178-year-old white spruce stand were broken as a result of snow and ice accumulation. The quantity of material deposited on the forest floor was about 11.2 and 13.3 metric tons per hectare in the black and white spruce respectively.

In both black and white spruce the greatest mass of selected nutrient elements and percentage concentration of elements, with three exceptions, occurred in the live branch component of the broken material.

Using estimates of the mass of N, P and K in the above ground parts of various spruce forests in the Russian taiga it can be estimated that the 1967-68 breakage in black and white spruce forests contained 6 to 10 percent of the N, 10 to 19 percent of the P and 10-15 percent of the K contained in the above ground portions of Alaska taiga spruce forests.

Unpublished: None

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Regeneration Requirements for White Spruce and Associated Species.

a. New Studies: None

b. Manuscripts:

Chlorophyll deficiency in white spruce (Picea glauca (Moench) Voss).

White spruce cone and seed production in interior Alaska, 1957-1968.

Frost damage to white spruce cones in interior Alaska.

Problem No. 2--Site productivity after alteration by fire and other causes.

a. New Studies: None

b. Manuscripts:

1) Ecology of river bottom sites in interior Alaska.

2) The status of Populus balsamifera and P. trichocarpa in Alaska.

3) Alaska Trees and Shrubs.

4) Accumulation of nitrogen in alder ecosystems developing on the Tanana River floodplain near Fairbanks.

Problem No. 3.--Growth patterns of white spruce and related species.

a. New studies: None

b. Manuscripts:

Secondary growth of northern white spruce. I. Features of the secondary vascular regions.

Secondary growth of northern white spruce. II. The seasonal pattern of cambial activity.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Annual Report for Pacific Northwest Forest and Range Experiment Station
Research Work Unit FS-PNW-1604 for Year Ending
March 31, 1970

1. Research Work Unit Location: Juneau, Alaska.

2. Research Work Unit Title: Erosion and Sedimentation, Coastal Forests.

3. Mission: To develop methods for improving water quality; for improving and managing fish habitat; for preventing erosion, sedimentation, and soil mass movements; and for restoring damaged land and stream channels to good hydrologic condition.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	1/6	0	2	0	3	0	1/5	0
2	1/3	0	0	0	0	0	1/3	0
3	0	0	0	0	0	0	0	0
4	4	0	0	0	1	0	3	0
Total	13	0	2	0	4	0	11	0

1/ Two studies reassigned from Problem 1 to Problem 2 due to refinement of objectives.

5. Accomplishments for Each Selected Problem:

Problem No. 1--Watershed Productivity in Terms of Fish Habitat.

a. Published:

Meehan, W. R., Farr, W. A., Bishop, D. M., and Patric, J. H. 1969. Some effects of clearcutting on salmon habitat of two southeast Alaska streams. U.S. Forest Serv. Res. Pap. PNW-82, 45 pp.

Three watersheds on Prince of Wales Island, Alaska, were studied to determine some of the physical effects of clearcutting on salmon fresh water habitat. Two of the streams were within the first major pulp timber harvesting area in southeast Alaska, with a third stream in an adjacent uncut watershed. About one-fourth of one watershed area and one-fifth of the other were clearcut and logged by high-lead methods. Measurements were made before, during, and after logging.

Effects of clearcutting on water yield were not within a detectable range. Based on experience elsewhere, an increase of 3 to 4 area-inches would have been reasonable, but the accuracy required to measure it would be prohibitively expensive. Clearcutting appeared to have little effect on stream regimen, perhaps because the areas logged were the lowermost elevations, annual precipitation exceeding 100 inches is fairly well distributed throughout the year, and soils are highly permeable with deep organic surfaces.

Suspended sediment concentrations in the main streams increased a small but statistically nonsignificant amount during logging, and had little effect on water quality. Road erosion and numerous landslides were sediment sources. However, much of the sediment produced was trapped before reaching the streams. Flashy contributions of sediment, as in the one case of a landslide reaching the main stream, were of brief duration.

The maximum increase, due to clearcutting, in average monthly stream temperature at the stream gaging sites was 4° F., and the maximum observed temperatures increased up to 9° F. for periods of a few hours during the summer. The highest stream temperature recorded was 69° F. which occurred for 18 hours over three days during the 14 years of record. The temperature increase is believed to be due mainly to removal of streamside timber.

Before logging, one stream contained 5 times as many log-debris jams as the other, evidently related to a denser timber stand in the first case. After logging the ratio increased to 5.6:1, partly because of poisoned streambank alder, which added to the stream debris. Log jams shifted during streamflow peaks and caused shifts in stream pool and riffle structure. Such jams caused increased streambed movement and reduced intragravel sediment accumulations.

Returns of pink and chum salmon increased after clearcutting, undoubtedly associated with factors other than logging. The probable increase in escapement resulting from fish trap removal in nearby water would be sufficient to mask fish production changes due to clearcutting--if such changes occurred.

The study was not concerned with fish species such as steelhead trout and coho salmon having extended fresh water stages in their life histories. In terms of pink and chum salmon, presently the most important commercial species in southeast Alaska, it appears that clearcutting and high-lead yarding, when carefully done, need not adversely affect the fresh water habitat.

Swanston, Douglas N. 1969. Mass wasting in coastal Alaska. U.S. Forest Serv. Res. Pap. PNW-83, 15 pp.

Mass wastage is the dominant process of natural erosion and slope reduction in geologically youthful southeast Alaska. Steep slopes and excessive soil-water contents are the principal causes of slide occurrence. Destruction of natural slope equilibrium and of stabilizing root systems are secondary factors. Slopes with gradients in excess of 34° (the lower limit of the internal angle of friction for most of the slope soils) are highly susceptible to sliding.

Land uses, especially timber harvesting by clearcutting, can only aggravate naturally unstable slope conditions. Acceleration of landslide occurrence can be prevented by avoiding susceptible slopes. However, more information is needed to determine the costs and benefits of resource use under such conditions.

Swanston, D. N. 1969. A late-Pleistocene glacial sequence from Prince of Wales Island, Alaska. Arctic 22(1): 25-33.

Evidence of two late-Pleistocene glacial advances was found in Maybeso Creek valley. A cemented "younger" till with a shallow weathered zone directly overlies a thoroughly leached and partly oxidized "older" till. The younger till was deposited by glaciation of regional extent representing the last major glacial

advance of classical Wisconsin age in southeast Alaska. The older till may also represent a regional glaciation, tentatively correlated with an intermediate to early-late Wisconsin age.

Four recessional moraines in the valley record dying pulsations of the glaciation that deposited the younger till during the early part of the late glacial interval preceding the Hypsithermal. Numerous debris avalanches have occurred in the younger till, many of them accelerated by timber harvesting.

b. Unpublished: None that will remain unpublished.

Problem No. 2--Fish Habitat Improvement and Management.

a. Published:

Meehan, William R. 1970. Some effects of shade cover on stream temperature in southeast Alaska. U.S. Forest Serv. Res. Note PNW-113, 9 pp.

In an exploratory study to develop a method for evaluating shade cover effects on stream temperatures, measurements were made with a portable resistance thermometer accurate to 0.01° C. at 20-yard intervals in shaded and unshaded reaches on cloudy and clear days in several southeast Alaska streams.

On clear sunny summer days the stream temperature increase per 20-yard reach without shade ranged from 0.02° C. to 0.21° C. and in shaded reaches the stream temperature decreased from 0.03° C. to 0.18° C. On overcast summer days the mean temperature increase per 20-yard reach in several streams in each of two areas was 0.011° C. and 0.009° C.

Shade is an important factor in maintaining the coolness of streams on clear sunny summer days. A highly accurate resistance thermometer is suitable for measuring temperature changes in short reaches of streams.

b. Unpublished: None that will remain unpublished.

Problem No. 3--Upper Slope Logging.

a. Published: None.

b. Unpublished: None.

Problem No. 4--Hydrology of Coastal Forest Watersheds.

a. Published:

Patric, James H. and Black, Peter E. 1968. Potential evapotranspiration and climate in Alaska by Thornthwaite's classification. U.S. Forest Serv. Res. Pap. PNW-71, 28 pp.

Climatic data for 315 stations were analyzed by Thornthwaite's methods to characterize the climates of Alaska and develop a generalized map of potential evapotranspiration. The climates of Alaska range from perhumid warm microthermal in the coastal belt, semiarid warm microthermal in the central interior basin, which is the "typical" Alaska climate, to semiarid tundra along the Arctic coast. The distribution of natural vegetation coincides reasonably well with estimated potential evapotranspiration despite the probability that vegetation distribution in Alaska is governed more by temperature than by moisture availability.

b. Unpublished: None that will remain unpublished.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Watershed Productivity in Terms of Fish Habitat.

a. New Studies:

(1) Relationship of stream energy factors to gravel stability in natural streams. (Study No. 40, not started in '69. Develop and test prototype system for unattended recording of depth of gravel movement.)

(2) Effects of forest fertilization on water quality. (Study No. 39. Cooperative study with FWPCA and NFS, water quality measurements for one year.)

Active Studies:

(1) Effects of gravel morphology on survival of salmon eggs and alevins. (Study No. 32. Install artificial redds in model stream bed.)

(2) Delineation of watershed productivity factors by aerial photo and map interpretation. (Study No. 33. Complete photo and map interpretation, select study watersheds.)

(3) Acute toxicity of various formulations of 2,4-D on juvenile coho, pink, and chum salmon. (Study No. 40. Continue laboratory tests in cooperation with Bur. Comm. Fisheries.)

b. Manuscripts:

(1) Measurement of creep in a shallow, slide-prone till soil. (Study No. 13. Submitted to Amer. J. Sci.)

(2) Mechanics of debris avalanches. (Study No. 11C. Research Note.)

(3) An improved technique for sampling stream bottom fauna. (Study No. 36. Proposed for Prog. Fish Cult.)

(4) Short-term effects of 2,4-D on aquatic organisms in the Nakwasina River Watershed, southeastern Alaska. (Study No. 37. Proposed for Pesticides Monitoring J.)

Problem No. 2--Fish Habitat Improvement and Management.

a. New Studies:

(1) Depth and lateral extent of gravel shift at different stream discharge levels. (Study No. 38. Model tests using local gravels.)

Active Studies:

(1) Effects of stream-side vegetation on stream temperature. (Study No. 28. Summer and winter field measurements of stream temperature and associated parameters.)

(2) Effects of removal of streamside vegetation on resident fish populations and stream bottom fauna. (Study No. 35. Complete field measurements at initial study site.)

b. Manuscripts:

(1) Effect of gravel cleaning on stream bottom fauna. (Study No. 27. Prog. Fish Cult.)

Problem No. 3--Upper Slope Logging.

a. New Studies: None.

b. Manuscripts: None.

Problem No. 4--Hydrology of Coastal Forest Watersheds.

a. New Studies: None.

Active Studies:

(1) Precipitation in relation to topographic parameters in the Juneau area. (Study No. 25. Explore possible use of high cirques as upper elevation precipitation gages. If feasible, then design plan. Install two sea level gages.)

(2) Glacial geology and soil formation on Vandeput Point, Thomas Bay, Alaska. (Study No. 34. Complete field work on glacial geology.)

b. Manuscripts:

(1) Performance of a high elevation precipitation gage. (Study No. 30. Research Note.)

(2) Glacial geology of Vandeput Point, Thomas Bay, Alaska. (Study No. 34. Research Note.)

UNITED STATES DEPARTMENT OF AGRICULTURE
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Annual Report for Pacific Northwest Forest and Range Experiment Station
Institute of Northern Forestry
Research Work Unit FS-PNW-2106 for Year Ending March 31, 1970

1. Research Work Unit Location: College, Alaska

2. Research Work Unit Title: Alaskan Fire Control Methods

3. Mission: To devise effective fire control methods for Alaska

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	3	0	0	0	0	0	3	0
2	1	0	0	0	1	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
Total	4				1		3	

5. Accomplishments for Each Selected Problem:

Problem No. 1--Fire Danger Rating

a. Published:

Barney, Richard J. 1969. National Fire-Danger Rating System Fine Fuel Moisture Content Tables--An Alaskan Adaptation. PNW Forest and Range Exp. Sta. Inst. Northern Forestry. U.S.Forest Service Res. Note PNW-109, 12 pp., illus.

Many of the weather records for Alaska have only dry bulb and dew point temperatures on them. Over 50 percent of the fire-danger

station network observations in Alaska are obtained from the Federal Aviation Administration and Weather Bureau teletype network stations which provide only dry bulb and dew point temperatures. Essentially then, data for Alaska--both of a historical nature and for daily operational use--was not available in a readily useable form. Therefore, fine-fuel moisture content tables, using dry bulb and dew point temperatures as entry data, were developed for use with the National Fire-Danger Rating System in Alaska. Comparisons have been made which illustrate differences resulting from danger-rating calculations based on these new fine-fuel moisture tables vs. the standard NFDRS tables. New fine-fuel moisture content tables for the cured, transition, and green herbaceous stages of fuel are provided.

b. Unpublished: None

Problem No. 2--Fire Control Planning

a. Published:

Barney, Richard J. 1969. Interior Alaska Wildfires, 1956-1965. Pacific Northwest Forest and Range Exp. Sta. Inst. of Northern Forestry. Misc. Pub., 47 pp., illus.

In the reporting period a total of 2,178 fires burned 6,598,000 acres of forest and range lands. The average size fire was 3,030 acres. Lightning fires accounted for 38 percent of all fires and 97 percent of the acreage burned; man-caused fires accounted for the balance. Although most fires were discovered when reasonably small (0 to 9-acre size class), 9 percent were not discovered until they had burned 90 acres or more, and these tend to enlarge greatly until controlled. Other statistics are reported for interior Alaska as a whole and for the Anchorage and Fairbanks districts of the Bureau of Land Management. This publication updates, reconciles, and expands somewhat comparable information contained in the previous publication by Hardy and Franks for the period ending in 1958. The result is a reasonably complete fire history for interior Alaska.

Noste, Nonan V. 1969. Analysis and Summary of Forest Fires in Coastal Alaska. Pacific Northwest Forest and Range Exp. Sta., Inst. of Northern Forestry. Misc. Pub., 12 pp., illus.

Heavy fuel concentrations, the existence of even-age stands, and old fire scars are reminders to avoid complacency in fire planning in coastal Alaska even though the area is characterized by well distributed and generally abundant precipitation. The fire problem is man-caused and tends to be clustered around populated and high-use areas. Fires tend to be small--only 7 percent reach 10 acres and larger. For the 12-year period (1956 through 1967) the annual average was 20 fires and 450 acres burned in Alaska's National Forests, although 3,360 acres burned in 1959. Because most fires are caused by recreationists, smokers, and land clearing and land occupancy activities, fire prevention programs should be so oriented.

b. Unpublished: None

Problem No. 3--Fire Attack Methods

a. Published:

Barney, Richard J. 1969. Root Feeder Suppresses Fires. Fire Control Notes. Vol. 30, No. 3, 2 pp., illus.

Heavy accumulations of fuels, particularly partially decomposed organic matter such as peat, moss, and humus once afire are difficult to extinguish because normal application procedures do not get water into the fuel where it is needed. Conventional nozzles have a tendency to throw fire brands and to waste water because of run-off. A root feeding nozzle, as used by tree surgeons, was modified for use with 1-1/2-inch national fire hose female thread adapter. The needle was equipped with a shut-off valve, and is approximately 40 inches long. The pointed tip has side holes which direct water in four directions. In field tests by Bureau of Land Management crews the device performed effectively and was well received by fire personnel, especially in controlling and mopping up deep burning fires. The tool not only uses considerably less water per unit of time than customary hose nozzles but it also places water at the desired depth.

b. Unpublished: None

Problem No. 4--Using Fire in Resource Management

a. Published: None

b. Unpublished: None

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Fire Danger Rating

a. New Studies:

(1) Altitude and aspect variations of fire danger in Alaska

(2) 24-hour fire danger variation

(3) Relationship of danger rating indexes to several fire behavior and fire effects or damage characteristics

b. Manuscripts:

(1) 24-hour fire danger variations in Alaska (research note)

(2) Relationships of danger ratings to measures of fire activity in interior Alaska (research note)

Problem No. 2--Fire Control Planning

a. New Studies:

(1) Determination of manpower and equipment output standards

(2) General effects of forest fires in interior Alaska as related to fire control criteria

(3) Evaluation of existing detection systems and methods in interior Alaska

b. Manuscripts: None

Problem No. 3--Fire Attack Methods

a. New Studies:

Water requirements for suppression of fine fuel fires in Alaska

b. Manuscripts:

Water dropping--An alternative fire attack method for Alaska. (Fire Control Notes)

Problem No. 4--Using Fire in Resource Management

a. New Studies: None

b. Manuscripts: None

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Institute of Northern Forestry
Research Work Unit FS-PNW-2206 for Year Ending March 31, 1970

1. Research Work Unit Location: Juneau, Alaska

2. Research Work Unit Title: Forest Insects, Coastal Forests

3. Mission: Development of measures for preventing losses caused by insects to forests and forest products.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	3	5	1	0	0	0	4	5
2	0	1	0	0	0	0	0	1
3	1	0	0	0	0	0	1	0
4	0	0	0	0	0	0	0	0
Total	4	6	1				5	6

5. Accomplishments for Each Selected Problem:

Problem No. 1--Defoliators

a. Published:

Schmiege, D.C. 1970. Hemlock sawfly. Forest Pest Leaflet 31 (revised--submitted to Washington Office). The revision of this leaflet includes new information on the biology of the hemlock sawfly and deletion of the applied control section. New biological information includes data on life history, fecundity, host preferences, and natural control factors.

Schmiege, D. C., and Crosby, David. 1970. Black-headed budworm. Forest Pest Leaflet 45 (revised--submitted to Washington Office). New biological information is included in this revised leaflet. The taxonomic position of the budworm has also been changed. The western species is now Acleris gloverana (Walsingham) and the eastern species is Acleris variana (Fernald). Studies in Alaska show that adverse weather, such as unusually warm weather during the larval period, may cause high insect mortality.

Werner, R. A. 1969. The amount of foliage consumed or destroyed by laboratory-reared larvae of the black-headed budworm, Acleris variana. Can. Entomol. 101: 286-290. Sitka spruce produces twice as many needles per linear inch of twig as western hemlock. Defoliation by the black-headed budworm, Acleris variana (Fern.) is more severe on hemlock than spruce because of differences in the phenological development of the hosts and in the feeding behavior of first- and second-instar larvae on each of the hosts.

Werner, R. A. 1969. Development of the black-headed budworm in the laboratory. J. Econ. Entomol. 62: 1050-1052. Two successive generations of Acleris variana (Fernald) were successfully reared in the laboratory on both western hemlock and Sitka spruce foliage. There was no difference in development time (egg to adult) between 1st generation budworms reared at an average temperature of 66°F. (range 58°-71°) and 2nd generation budworms reared at 71°F. (range 69°-72°). The average development time of budworms (egg to adult) was approximately equal when reared on hemlock and spruce. Female budworms had a longer life span (88 days) than males (77 days) when reared on either hemlock or spruce. This difference in life span was greatest in the adult stage.

b. Unpublished:

Torgersen, T. R. 1970. Parasites of the black-headed budworm, Acleris gloverana (Walsingham) (Lepidoptera: Tortricidae). Accepted for publication by Can. Entomol. The parasites known to attack the black-headed budworm in Alaska and the relative importance of each species are presented. A key for the identification of parasite adults and notes on the bionomics of each species are given. The list of parasites includes 16 species, contrasting sharply with the 48 species reported from coastal British Columbia.

Only 2 species, Triclistus pallipes Holmg. and Meteorus argyrotaeneae Johansen, appear in the Alaskan complex that do not also appear in the list from British Columbia. Trichogramma minutum Riley, the only egg parasite, caused up to 22 percent mortality. Four species attacking various larval instars caused 2 to 72 percent mortality within single larval collections. Two pupal parasites, Itoplectis quadricingulatus (Prov.) and Phaeogenes arcticus Cush., were reared from 10 to 31 percent of pupae collected in the field.

Torgersen, T. R. 1970. Parasites of the western hemlock looper, Lambdina fiscellaria lugubrosa (Hulst), in southeast Alaska (Lepidoptera: Geometridae). Submitted to the Pan-Pacific Entomologist. The western hemlock looper, Lambdina fiscellaria lugubrosa (Hulst), was collected in Alaska for the first time in 1965. Field collections and laboratory rearings to obtain life history data and to determine parasitization were conducted during 1966. Eight species of ichneumonid parasites were reared from looper pupae, but none emerged from eggs or larvae. The most common pupal parasite was Aoplus velox occidentalis (Harrington). Four species, A. velox occidentalis, Pimpla pedalis (Cress.), P. aquilonia (Cress.), and Apechthis ontario (Cress.), constituted about 97 percent of the parasites reared. Two additional species, Pimpla hesperus (Townes) and Cratichneumon ashmeadi (Shulz), are new parasite records for the looper. A key for the identification of parasite adults and brief notes on the biology of each species are given.

Parasite studies at McKenzie Inlet, about 40 miles west of Ketchikan, show a high degree of parasitization. Dissections of unopened cocoons indicate that mortality due to parasites may be 50 percent. The most common parasite is Opidnus tsugae, accounting for one-third of the total from eight species collected.

Three parasite species were collected and identified that had not previously been collected from the hemlock sawfly anywhere. They are Alegina apantelis (Cush.), Mastrus aciculatus (Prov.), and Mastrus hydrophilus (Ashm.). In addition two species, not previously known from the sawfly in Alaska, were collected. They are Bathythrix areolaris (Cush.) and Bathythrix latefrons Cush. Two additional parasite species collected this past year remain undescribed.

Preference for crown levels varies between parasite species. Some prefer upper crowns for activity and several prefer middle or lower crowns. This information is needed to properly analyze parasitization from sampling host populations.

Problem No. 2--Insects Affecting Regeneration

a. Published: None

b. Unpublished: None

Problem No. 3.--Detection and Appraisal Methods

a. Published: None

b. Unpublished: None

Problem No. 4.--Bark Beetles

a. Published: None

b. Unpublished: None

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1.--Defoliators

a. New Studies:

(1) Field and laboratory studies on the biology of the saddleback looper, Ectropis crepuscularia (Schiff.).

b. Manuscripts:

Parasites of the hemlock looper, Lambdina fiscellaria lugubrosa (Hulst), in southeastern Alaska (technical journal).

Biology of Ectropis crepuscularia (Schiff.) (technical journal).

New parasite records for three defoliator species in southeast Alaska (Station research note).

Effects of starvation during late larval stages on survival and fecundity of the hemlock sawfly (technical journal).

Problem No. 2.--Insects Affecting Regeneration

a. New Studies: None

b. Manuscripts: None

Problem No. 3.--Detection and Appraisal Methods

a. New Studies:

(1) Black-headed budworm egg sampling to assess population trends and resulting tree damage.

(2) Extensive sampling to determine relationships between defoliator densities, host growth, and seasonal weather.

b. Manuscripts:

A sequential sampling plan for hemlock sawfly eggs (Station research note).

Problem No. 4.--Bark Beetles

a. New studies: None

b. Manuscripts: None

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Annual Report for Pacific Northwest Forest and Range Experiment Station
Institute of Northern Forestry
Research Work Unit FS-PNW-2207 for Year Ending March 31, 1970

1. Research Work Unit Location: College, Alaska

2. Research Work Unit Title: Forest Insects--Interior Alaska

3. Mission: To develop biologically and economically sound methods of preventing and controlling excessive damage by insects to interior Alaska's forests.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	1	0	1	0	0	0	2	0
Total	1		1				2	

5. Accomplishments for Each Selected Problem:

Problem No. 1--The Biology and Ecology of Important Forest Insect Pests

a. Published: None

b. Unpublished:

Adult flight of the spruce beetle, Dendroctonus rufipennis, was investigated at Dry Gulch (Kenai Peninsula) and at Bonanza Creek (Fairbanks area) about 300 airline miles north. At both locations flight began soon after snow disappeared in forest stands and lasted 3 to 4 weeks. The flight period at Bonanza Creek began about two weeks earlier than at Dry Gulch. Fifty percent of the

total adult flight was completed by May 28 at Bonanza Creek and June 12 at Dry Gulch. Mean daily temperatures are generally higher in spring and early summer at Bonanza Creek than at Dry Gulch. Control of the spruce beetle by removal of traps or infested trees must be done early--before adult flight--to be most effective.

The rate of spread of the spruce beetle was investigated at Dry Gulch. The percentage of infested trees increased from 7.7 to 22.4 during the summer of 1969. Most of the attacked trees were of larger diameter and/or with their root systems in wet situations.

A total of 23 different insect parasites have been recovered from the large aspen tortrix, Choristoneura conflictana, from 1966 to date. Phaeogenes hariolus, Glypta fumiferanae were the most prevalent species reared. A "key" has been prepared to identify the various species based on adult characters.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

a. New Studies:

(1) Influence of temperature on development and survival of spruce insects.

(2) Infestation density of the spruce beetle in relation to felling date of white spruce.

(3) Mortality factors of white spruce in interior Alaska--an impact study.

b. Manuscripts:

(1) Effect of host on survival and fecundity of the large aspen tortrix.

(2) Parasites of the large aspen tortrix in interior Alaska.

UNITED STATES DEPARTMENT OF AGRICULTURE
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1. Research Work Unit Location: Juneau, Alaska

2. Research Work Unit Title: Forest Survey for Alaska

3. Mission: To collect, analyze, and report basic inventory data describing the forests of Alaska and their use, and to keep these data and analyses current through continuous and periodic inventory procedures.

4. Summary of Research Work Unit Studies for Each Selected Problem:

Study-Status Table for Research Work Unit

Problem number	April 1, 1969		Changes during year				March 31, 1970	
	Active	Inactive	Begun	Reactivated	Completed	Terminated	Active	Inactive
1	8	0	0	0	0	0	8	0
2	4	0	0	0	0	0	4	0
Total	12	0	0	0	0	0	12	0

5. Accomplishments for Each Selected Problem:

Problem No. 1--Coastal Alaska Inventory

a. Published: None

b. Unpublished:

Prepared a preliminary statistical report of the Yakutat unit of the Juneau working circle. For the 1967 inventory, a better measurement reduced the total land area under consideration by 28,900 acres from the 1957 estimates. The inventory reduced the forest land by 48,100 acres and increased the area of sawtimber stands by 27,150 acres. The sampling error for total commercial forest land on this unit was 4.6 percent in 1957 and 3.8 percent in 1967.

The total volume and volume per acre estimates were less in 1957 than in 1967. More confidence is placed in the 1967 inventory because of a better sample and resulting lower sampling error. The 1967 volume estimates are being recomputed with a new, improved volume table which will show slightly more volume than now shown in the preliminary tables.

Problem No. 2--Interior Alaska Inventory

a. Published: None

b. Unpublished:

Volume tables and formulas for white spruce and hardwoods of the Kuskokwim River drainage.

6. Research Work Unit's Plans for Next Year for All Selected Problems:

Problem No. 1--Coastal Alaska inventory

a. New Studies: None

b. Manuscripts:

Timber resources of the Haines-Skagway area.

Volume tables and equations for Sitka spruce trees at Yakutat.

Problem No. 2--Interior Alaska inventory

a. New Studies: None

b. Manuscripts:

Timber resources of the Susitna River valley

Volume tables and equations for white spruce of the Kuskokwim River drainage.

Forest inventory statistics for the Kuskokwim River drainage

Forest inventory statistics for the Copper River drainage